THE COSTS AND BENEFITS OF HIGH PERFORMANCE BUILDINGS

LESSONS LEARNED

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As Executive Director of Earth Day New York and environmental consultant to The Durst Organization since 1996, I have been happy to be a participant in some of the early efforts to engage the real estate, design and construction industries to find a more environmentally responsible way to conduct their business.

I'm not sure that anyone could have predicted the rapid expansion of the market for "high performance, sustainable or green buildings" but it is undeniable...things have really changed.

In less than a decade, we have seen skyrocketing growth of membership in the US Green Building Council (USGBC). Some of the largest developers, owners and builders in the country have embraced a dramatically different way of designing and constructing buildings that has resulted in the projects described here and many others.

The economics are becoming increasingly clear. The price for "green" or sustainable products is dropping. The marketplace is responding competitively to the demand for recycled content, higher efficiencies, rapidly renewable materials and other green features. The challenge is no longer simply breaking into the marketplace; the focus is on making it cost-effective.

The good news is...depending on your choices...it already is! If the trend continues, we should soon be able to achieve healthier, more efficient, better buildings at an even lower first cost than traditional buildings.

This is the third "Lessons Learned" publication that Earth Day New York has produced in an effort to provide succinct and useful information on these issues in an easy-to-read format. In *The Costs and Benefits of High Performance Buildings*, we have excerpted three comprehensive studies on the cost of "green" and have highlighted a variety of interesting projects in the office, institutional and residential sectors. We hope to jumpstart your own exploration of these issues and share some of the information and "lessons learned" that we have found useful or informative.

Many thanks are in order, especially to our sponsors, advertisers, authors and cooperating organizations. Lauren Gunlogson and Erin East, the Earth Day New York staff, deserve a lot of credit. They have worked long and hard to chase down the million details involved in a publication of this nature. As always, our designers, Avenue C Productions have done an extraordinary job. And, a final word of thanks and appreciation to Douglas and Jody Durst, for their continuing vision and commitment to leading their industry into the 21st Century.

Pamela Lippe

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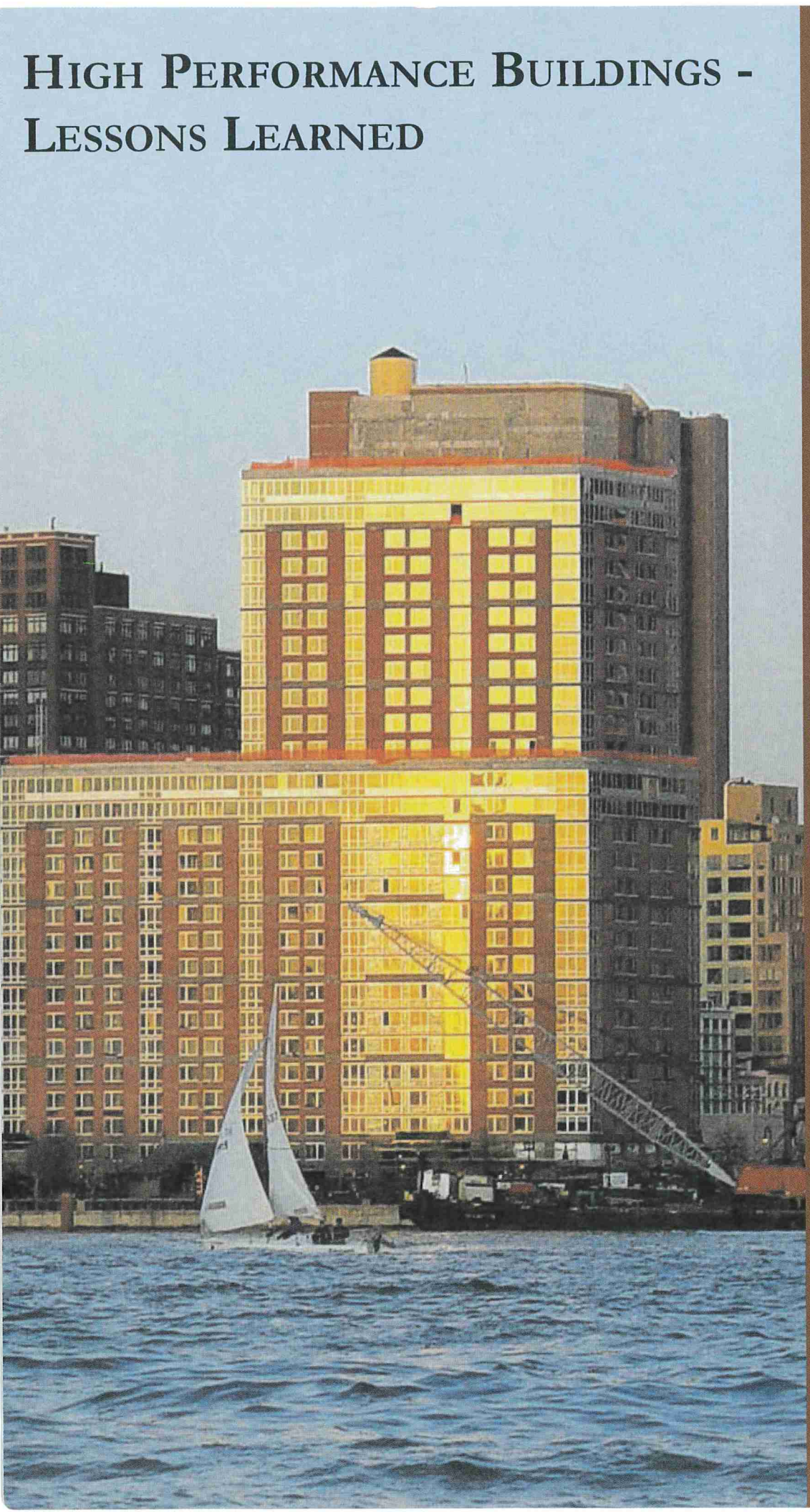
High Performance Buildings - Lessons Learned



THE SOLAIRE, at 20 River Terrace, is a 27-story residential tower in Battery Park City, only a few blocks from the World Trade Center site. It is heralded as the first green, high-rise residential building in the world with its unique design being featured as a bench-mark in the redevelopment of lower Manhattan.

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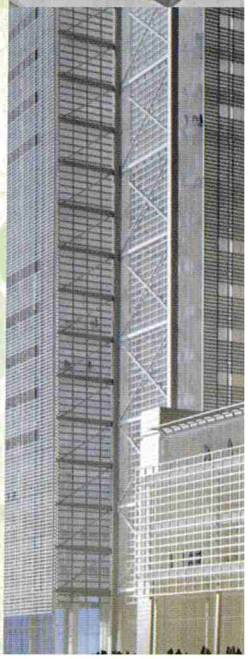

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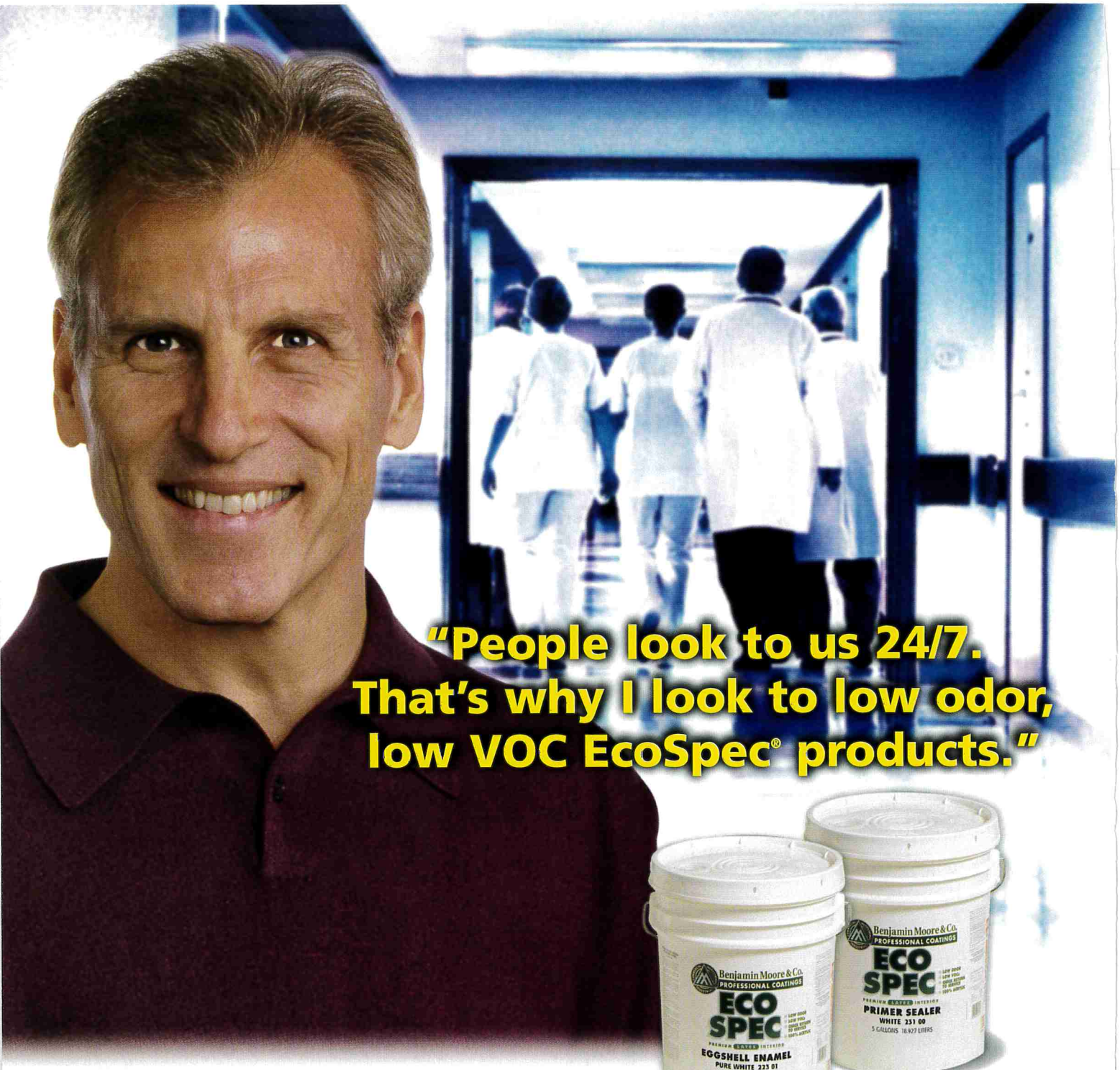

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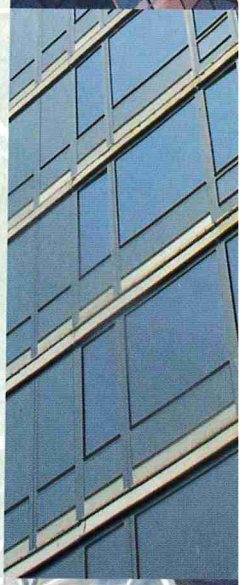

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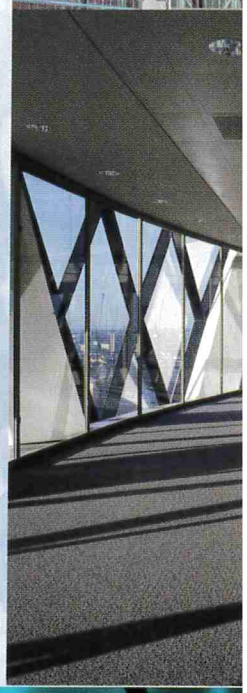

Environmental responsibility is the future of real estate – the choice is not whether, but when. As the public begins to understand that healthier and more productive buildings are possible, they will demand them. Smart companies, well positioned in the marketplace will benefit.

Douglas Durst
On Common Ground,
Realtors & Smart Growth

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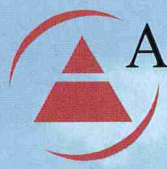

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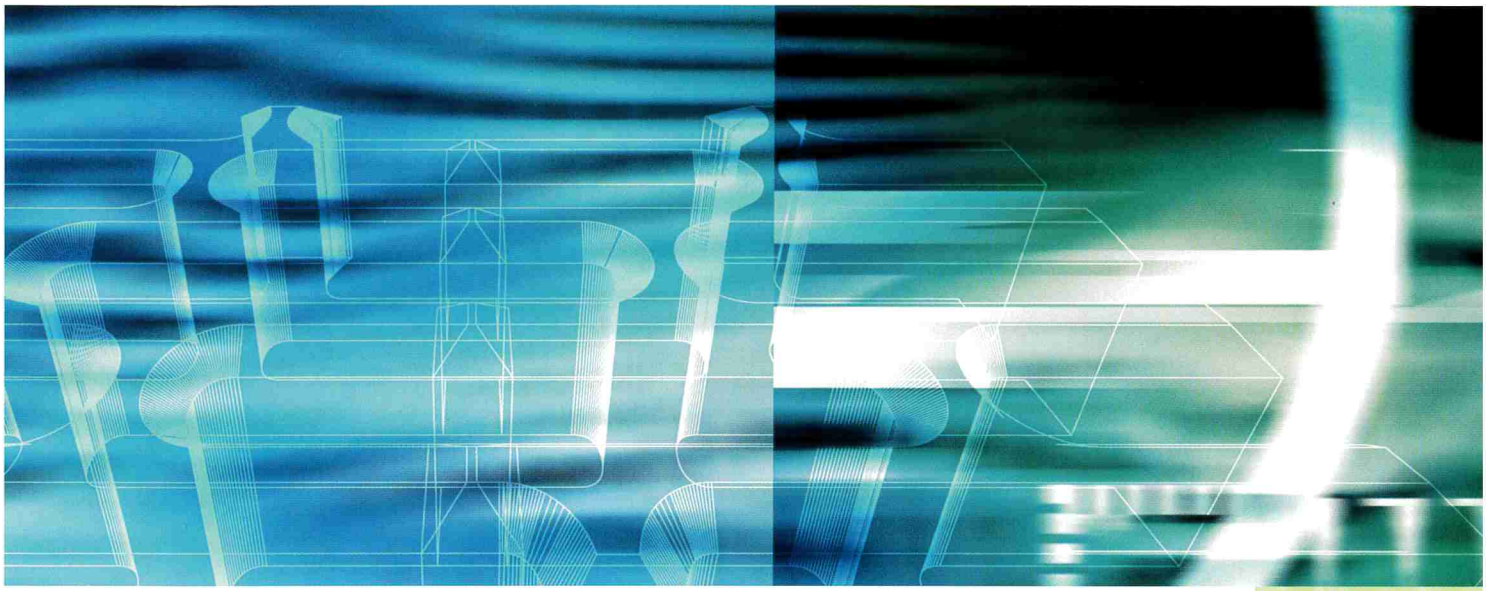


THE COSTS AND FINANCIAL BENEFITS OF HIGH PERFORMANCE BUILDINGS

Greg Kats, Capital E

This article draws heavily on a Report to California's Sustainable Building Task Force, October 2003, California Sustainable Building Task Force, available at www.cap-e.com.

"Green" or "high performance" buildings use key resources including energy, water, materials and land more efficiently than buildings that are just built to code. With more natural light, better air quality and greater comfort, green buildings typically also contribute to improved occupant health, comfort and productivity.

The benefits of high performance buildings are relatively clear but thorough analysis of the cost implications has not been available until recently. "The Costs and Financial Benefits of Green Buildings, A Report to California's Sustainable Building Task Force"[1] was released in October 2003 and was the first attempt to develop a rigorous analysis of the costs and benefits of green buildings. A draft of the report helped persuade the University of California Board of Regents to adopt a university-wide policy for the design of green buildings. Since then, the report has been widely circulated and highly influential (e.g., as a rationale for the 2004 legislation in New York City that mandates green design for all public buildings).

The analysis outlined below assumes a discount rate of 7%, including 2% inflation, and a 20 year term in developing a present value and net present value estimate for green buildings. This is conservative since many buildings last 50 years or longer.

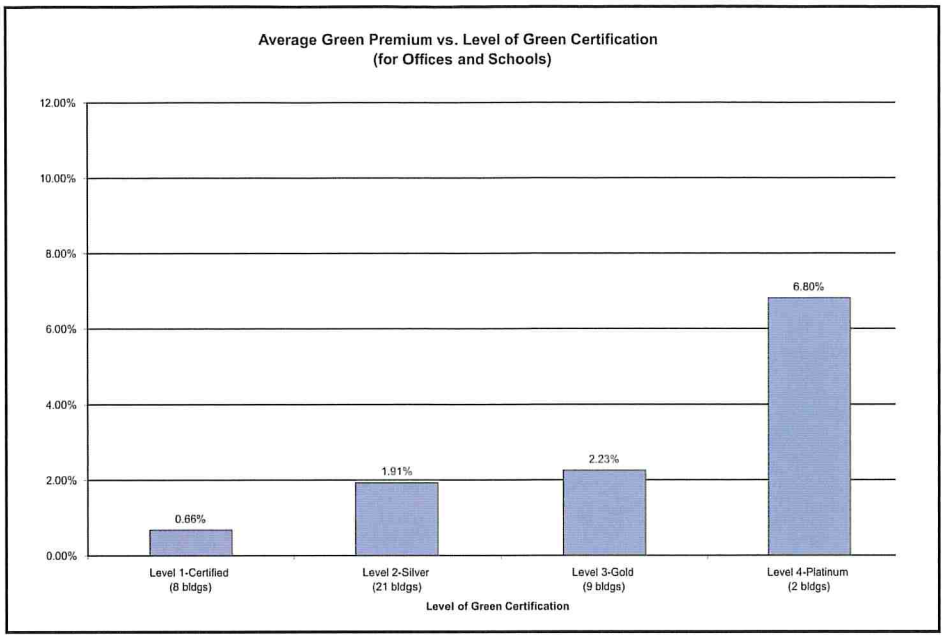
Analyzing the Costs

Cost data was gathered on 40 individual LEED® registered projects (32 office buildings and 8 school buildings) with actual or projected dates of completion between 1995 and 2004. These 40 projects were chosen because relatively solid cost data for both actual green design and conventional design was available for the same building.[2]

The eight Bronze or Certified buildings had an average cost premium of 0.7%. Twenty-one Silver-level buildings averaged a 1.9% cost premium. The nine Gold buildings had an average premium of 2.2%, and the

[1] "Principal Author: Greg Kats, Capital E, Contributing Authors: Leon Alevantis, Department of Health Services, Adam Berman, Capital E, Evan Mills, Lawrence Berkeley National Laboratory, and Jeff Perlman, Capital E. The report was developed for the Sustainable Building Task Force, a group of over 40 California state government agencies. Funding for this study was provided by the Air Resources Board (ARB), California Integrated Waste Management Board (CIWMB), Department of Finance (DOF), Department of General Services (DGS), Department of Transportation (Caltrans), Department of Water Resources (DWR), and Division of the State Architect (DSA). This collaborative effort was made possible through the contributions of Capital E, Future Resources Associates, Task Force members, and the United States Green Building Council.

[2] See the chapter "Valuing Green Buildings" in Greg Kats' forthcoming untitled book to be published by the US Green Building Council, which reviews 40 buildings (The California Sustainable Building Task Force report contains cost data for 33 green buildings).



A clear trend of declining costs associated with increased experience in building green has been experienced in Pennsylvania,[3] as well as in Portland and Seattle. Portland's three completed LEED Silver buildings were finished in 1995, 1997, and 2000. They incurred cost premiums of 2%, 1% and 0% respectively.[4] Seattle has seen the cost of LEED Silver buildings drop from 3-4% several years ago to 1-2% today.[5]

two Platinum buildings were at 6.8%. The average reported cost premium for all 40 buildings is almost 2%. Assuming conservative, relatively high commercial construction costs of $150/ft^2 to 250/ft^2, a 2% green building premium is equivalent to $3-5/ft^2.

Reduced Energy Use

The green buildings in the study used an average of 28% less purchased energy than conventional buildings. For energy costs of $1.47/ft^2/yr for California public buildings, this indicates savings of about $0.44/ft^2/yr,[6] with a 20-year present value of $5.48/ft^2. The national average was $1.55/ft^2 for commercial buildings, or an NPV of $5.78/ft^2.

By encouraging integrated design and awarding credit for optimization of energy systems, LEED buildings substantially cut peak demand. In addition, LEED buildings were more likely to purchase "green power" or green certificates for electricity generated from

Reduced Energy Use in Green Buildings as Compared with Conventional Buildings

	Certified	Silver	Gold	Average
Energy Efficiency (above standard code)	18%	30%	37%	28%
On-Site Renewable Energy	0%	0%	4%	2%
Green Power	10%	0%	7%	6%
Total	**28%**	**30%**	**48%**	**36%**

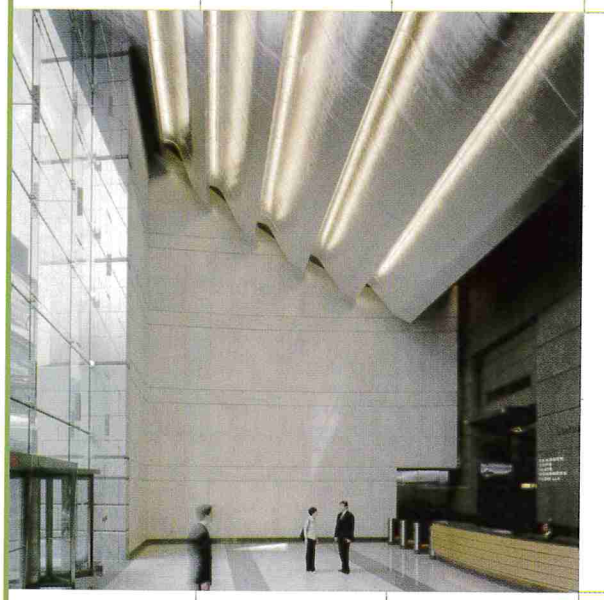
Source: USGBC, Capital E Analysis

[3] Data provided by John Boecker, L. Robert Kimball and Associates, A/E Firm for the Pennsylvania Department of the Environment Cambria Office Building, Ebensburg, PA, the PA Department of Environmental Protection Southeast Regional Office. Norristown, PA, and the Clearview Elementary School, York, PA.
See: http://www.lrkimball.com/Architecture%20and%20Engineering/ae_experience_green.htm.

[4] Data provided by Heinz Rudolf, BOORA Architects. See Portfolio/Schools at: http://www.boora.com/

[5] Lucia Athens, Seattle Green Building Program, Nov. 2002. See: http://www.cityofseattle.net/light/conserve/sustainability/. Seattle is undertaking a review of over a dozen green Seattle buildings and specific costs premiums for these buildings.

[6] 30% of $1.47/ft^2/yr total energy costs at 5% discount rate over 20 year term.



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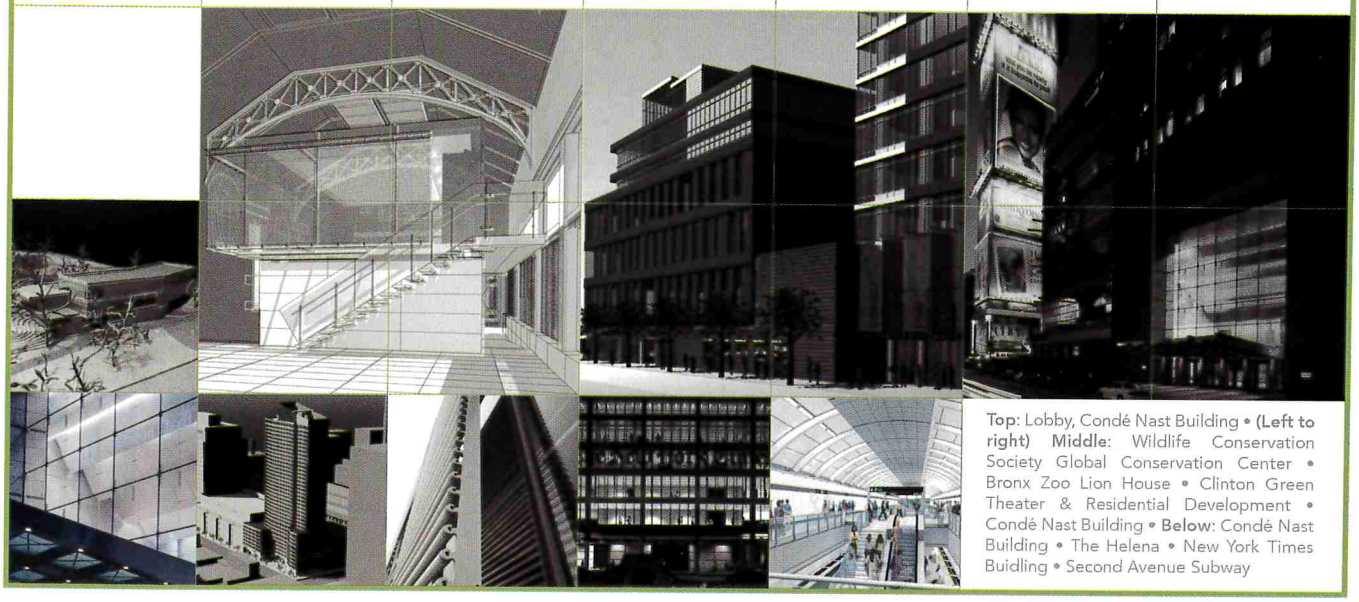


Top: Lobby, Condé Nast Building • **(Left to right) Middle**: Wildlife Conservation Society Global Conservation Center • Bronx Zoo Lion House • Clinton Green Theater & Residential Development • Condé Nast Building • **Below**: Condé Nast Building • The Helena • New York Times Buidling • Second Avenue Subway

renewable energy sources. For example:

- *High Performance Lighting:* Incorporation of more efficient lights, task lighting, use of sensors to cut unnecessary lighting, use of daylight harvesting and other advanced lighting techniques and technologies. These measures can significantly reduce power demand and heating loads in a building, which in turn reduces required air conditioning.
- *Increased Ventilation Effectiveness:* Helps cut air conditioning load during peak times through improved system optimization.
- *Heat Island Reduction Measures:* By increasing the reflectivity of roofs and other typically dark surfaces, it is possible to lower building and urban temperatures, in turn reducing air conditioning loads and peak demand.

Evaluation of LEED documentation for over a dozen buildings[7] indicates an average reduction in energy use of 30%, but an average peak reduction of about 40%.[8] The data set is limited and this is a rough estimate. Nonetheless it seems clear that green buildings reduce peak demand to a greater degree than total energy consumption.

The benefits of reduced energy use are greatest during periods of peak power consumption – helping to avoid congestion costs, fewer power quality and reliability problems, pollution, and less capital investment needed to expand generation and transmission and distribution infrastructure.

The study estimates the 20-year present value of the peak demand reduction attribute of green buildings at $0.31/ft^2 ($0.025/year, at 5% real discount rate over 20 years). These are preliminary approximations based on limited data. The value of peak demand and peak capacity reduction is likely to be higher than estimated here.

Together, the total 20-year present value of financial energy benefits from a typical green California public building is $5.79/ft^2. For US commercial buildings, the NPV of energy savings is $6.09/ft^2. Thus, on the basis of energy savings alone, investing in green buildings appears to be cost-effective.

Reduced Pollution

Buildings use 70% of the nation's electricity. Air pollution from burning fossil fuels to generate electricity imposes very large health, environmental and property damage costs. Demonstrated health costs include tens of thousands of additional deaths per year and tens of millions of respiratory incidents and ailments.[9] The health, environmental and property damages associated with pollution from burning fossil fuels – commonly referred to as externalities – are only very partially reflected in the price of energy.[10]

A report published in July 2002 for the United Nations Environmental Program's Finance Initiatives Climate Change Working Group, Climate Change and the Financial Services Industry, warns that the "increasing frequency of severe climatic events, coupled with

20-Year PV of 36% Pollution Reduction for California Buildings ($/ft^2)

	CO_2 PRICE	
Pollutant	$5/ton	$10/ton
NOx	$0.54	$0.54
PM10	$0.41	$0.41
SOx	$0.16	$0.16
CO2	$0.07	$0.14
Total	**$1.18**	**$1.25**

Source: Capital E Analysis

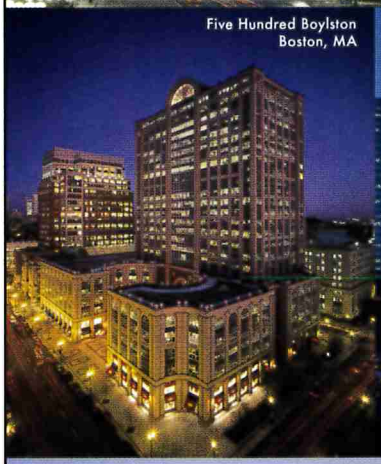
[7] Data provided by the USGBC, analysis by Capital E with USGBC. November and December, 2002.

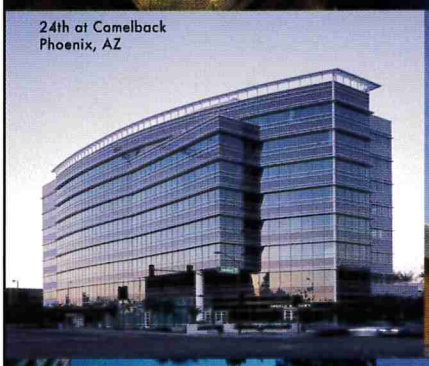
[8] Because USGBC does not require that peak load reduction data be submitted, the data quality is mixed and includes some buildings that specify peak load demand reduction and some building data that indicates this indirectly (e.g., through large reductions in air conditioning load).

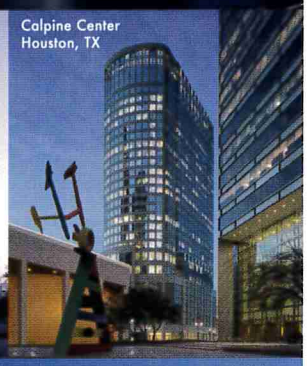
[9] See, for example: "The Benefits and Costs of Clean Air Act 1990 to 2010," 1991. Available at: http://www.epa.gov/air/sect812/1990-2010/fullrept.pdf and Jonathan Samet et al., "The National Morbidity, Mortality, and Air Pollution Study – Part II: Morbidity and Mortality From Air Pollution In the United States," Health Effects Institute, 2000. Available at: http://www.healtheffects.org/Pubs/Samet2.pdf.

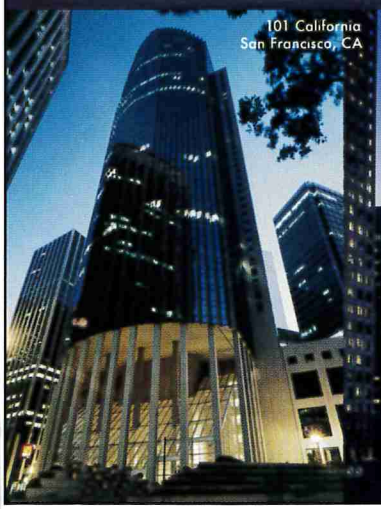
[10] For a valuable introduction and overview of past studies on externality cost and costs of emissions reductions, see Jonathan Koomey and Florentin Krause, "Introduction to Externality Costs," LBNL, 1997. Available at: http://enduse.lbl.gov/Info/Externalities.pdf.

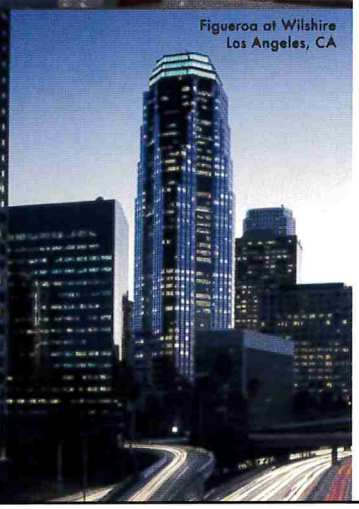
Hines Means High Performance











Hines received the Environmental Protection Agency's ENERGY STAR Partner of the Year Award in 2001, 2002 and 2003. Now in 2004, 80 Hines buildings are ENERGY STAR certified, and the firm became the only real estate business to receive the EPA's ENERGY STAR Sustained Excellence Award.

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social trends, has the potential to stress insurers, reinsurers and banks to the point of impaired viability or even insolvency."[11] The United Nations estimates the potential cost of global warming at over $300 billion per year, and insurance firms are becoming concerned about the possibility of lawsuits due to damage from human-induced global warming.[12]

Recognizing the cost of global warming by assigning a dollar value of some amount is preferable to the current practice of assigning no value – effectively $0 – to CO_2 reductions. It is also economically efficient for States and public bodies to explicitly recognize a value for CO_2 in order to ensure a more cost-effective decision making process about building design choices, but determining a value for CO_2 reduction is a difficult proposition. For example, a recent Intergovernmental Panel on Climate Change (IPCC) report cites a range of values between $5 and $125 per ton of CO_2.[13] This analysis assumed the lowest estimates of $5 and $10 per ton for CO_2.

Detailed calculations in the Task Force Report indicate a present value of reduction in emissions of the four pollutants discussed above of about $1 per ft^2. This is almost certainly very low.

Reduced Water Use

Much of the United States is facing the prospect of worsening water shortages and sinking aquifers. Green buildings typically use half as much water as conventional buildings and can therefore play a substantial role in cutting the costs of water supply and the costs of waste water treatment.

Green building water conservation strategies generally fall into four categories:

- Efficiency of potable water use through better design/technology;
- Capture of gray water – non-fecal waste water from bathroom sinks, bathtubs, showers, washing machines, etc. – and use for irrigation;
- On-site stormwater capture for use or groundwater recharge; and
- Recycled/reclaimed water use.

Taken together, these strategies can reduce water use below code/common practice by over 30% indoors and over 50% for landscaping.[14] Of 21 reviewed green buildings submitted to the USGBC for LEED certification all but one used water efficient landscaping, cutting outdoor water use by at least 50%. Seventeen buildings, or 81%, used no potable water for landscaping. Over half cut water use inside buildings by at least 30%. Typical green buildings cut water use by about half.

The California report provides an estimate 20-year PV of $0.51/$ft^2$ for water savings from green buildings in California. These costs are very likely conservative.

Reduced Waste

Green buildings recycle and divert substantially higher levels of waste, and incorporate greater amounts of recycled or "re-used" materials than conventional buildings. Waste reduction strategies such as reuse and recycling, as promoted in green buildings, help to divert waste from being disposed of in landfills and result in savings associated with avoided disposal costs as well as in reduced societal costs of landfill creation and maintenance.

Of 21 green buildings submitted to USGBC for certification, seventeen, or 81%, reduced construction waste by at least 50%, while 38% reduced construction waste by 75% or more.[15]

In the absence of good data on present rates of waste diversion in green and conventional buildings during both their construction and operation, it is impossible to quantify the full value of green building resulting from lower waste generation. The one year value of reduced construction waste from green buildings in California is estimated to be $0.03/$ft^2$ and this (very low) waste benefit number is included in this report. A thorough analysis is likely to find average national waste related financial benefits over $0.50/ ft^2.

Improved Productivity and Health

There is growing recognition of the large health and productivity costs imposed by poor indoor environmental quality (IEQ) in commercial buildings. This is not surprising as people typically spend 90% of their time indoors, and the concentration of pollutants indoors is typically higher than outdoors, sometimes by as much as 10 or even 100 times.[16] The costs of

[11] Innovest, for the United Nations Environmental Program. Finance Initiatives Climate Change Working Group. "Climate Change and the Financial Services Industry," 2002. Available at: http://www.unepfi.net/.

[12] Katharine Q. Seeley, Global Warming May Bring New Variety of Class Action," New York Times, September 6, 2001. Available at: http://www.commondreams.org/headlines01/0906-03.htm.

[13] IPCC Working Group III, "Summary for Policymakers: The Economic and social Dimensions of Climate Change," 2001. Available at: http://www.ipcc.ch/pub/sarsum3.htm.

[14] US Green Building Council LEED Reference Package, Version 2.0, June 2001, p. 65, and analysis of green buildings submitted to USGBC. Available for purchase at: http://www.usgbc.org/LEED/publications.asp.

[15] Data provided by USGBC.

[16] US Environmental Protection Agency, "Indoor Air Quality," January 6, 2003. Available at: http://www.epa.gov/iaq/.

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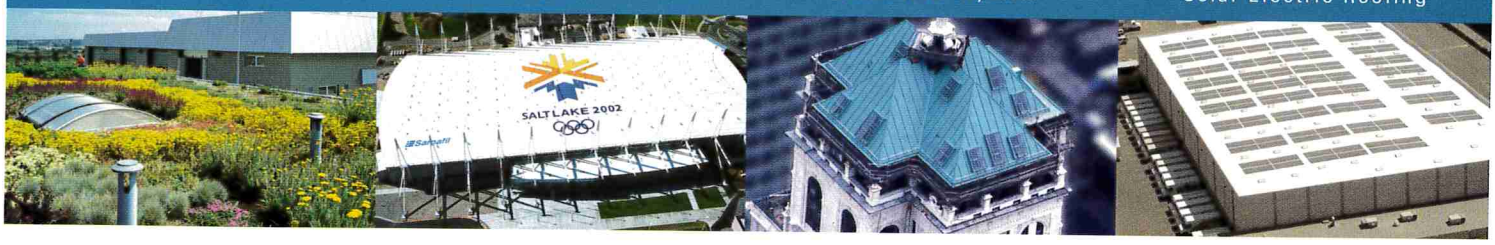

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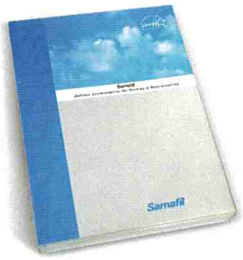

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poor indoor environmental and air quality – including higher absenteeism and increased respiratory ailments, allergies and asthma – are hard to measure and have generally been "hidden" in sick days, lower productivity, unemployment insurance and medical costs. Health and productivity issues, often addressed separately, are combined here because both relate directly to worker well-being and comfort and both can be measured by their impacts on productivity.

The discussion of indoor environmental quality (IEQ) and productivity issues in industry publications expanded rapidly in the last decade and has spilled over into popular media. Business Week's cover for its June 5, 2000 issue, for example, features a picture of a large menacing office building to accompany the feature story: "Is Your Office Killing You? The Dangers of Sick Buildings."[17] The article cites potential benefits of up to $250 billion per year from improved indoor air quality in US office buildings.

Gary Jay Saulson, the Senior VP and Director of Corporate Real Estate for PNC Realty Services, describes the benefits of the LEED Silver PNC Firstside Center building in Pittsburgh as follows: "People want to work here, even to the point of seeking employment just to work in our building. Absenteeism has decreased, productivity has increased, recruitment is better and turnover less." Two business units experienced 83% and 57% reductions in voluntary terminations after moving into the new Firstside facility.[18]

Attributes common in green buildings that promote healthier work environments include more daylighting, and improved thermal and ventilation control and comfort. Much better indoor air quality is provided by measures such as better siting (e.g., avoiding locating air intakes near parking garages), and better building material source controls. Certified and Silver level green buildings achieved 55% and Gold level LEED buildings achieved 88% of possible LEED credits for use of a range of IEQ related measures, including the following:[19]

a. less toxic materials
b. low-emitting adhesives & sealants
c. low-emitting paints
d. low-emitting carpets
e. low-emitting composite wood
f. indoor chemical & pollutant source control

There is a large body of technically sound studies and documentation linking health and productivity with specific building design operation attributes – e.g., indoor air quality and tenant control over work environment, including lighting levels, air flow, humidity and temperature. For example, two studies of over 11,000 workers in 107 European buildings analyzed the health effect of worker-controlled temperature and ventilation. They found significantly reduced illness symptoms, reduced absenteeism and increases in perceived productivity over workers in a group that lacked these features.[20]

Productivity Benefits

One of the leading national centers of expertise on the benefits of high performance buildings is the Center for Building Performance at Carnegie Mellon University. They have reviewed over 1000 studies that relate technical characteristics of buildings, in areas such as lighting and ventilation, to tenant responses, such as productivity. Collectively, these studies demonstrate that better building design and performance in areas such as lighting, ventilation and thermal control correlate to increases in tenant/worker well-being and productivity.[21]

Increases in tenant control over ventilation, temperature and lighting each provide measured benefits from 0.5% up to 34%, with average measured workforce productivity gains of 7.1% with lighting control, 1.8% with ventilation control, and 1.2% with thermal control. Additionally, measured improvements have been found with increased daylighting, as discussed in the following section.

Eight studies measured the relationship between increased lighting control and productivity, finding productivity gains ranging from 3% up to 34%, with a mean of 7.1%. The subsequent figure was supplied by the Department of Architecture at Carnegie Mellon

[17] Michelle Conlin, "Is Your Office Killing You?" *Business Week*, June 5, 2000, http://www.businessweek.com/2000/00_23/b3684001.htm

[18] Compared with a control group that experiences an 11% reduction. "Shades of Green: 2002 Report of the Pittsburgh Green Building Alliance," http://www.gbapgh.org. See also: William Browning, "Successful Strategies for Planning a Green Building" *Planning for Higher Education*, Society of College and University Planners, March-May 2003, pp. 78-86.

[19] Capital E analysis of USGBC data (based on analysis of points actually achieved in building performance data submitted to USGBC), November and December 2002. For more detail on achievable reductions from some of these indoor emissions sources, please see: Hodgson AT. "Common Indoor Sources of Volatile Organic Compounds: Emissions Rates and Techniques for Reducing Consumer Exposures." University of California, Lawrence Berkeley National Laboratory. 1999. Prepared for California Air Resources Board. Available at: http://www.arb.ca.gov/research/apr/past/indoor.htm#Toxic%20Air%20Contaminants

[20] Judith Heerwagen, "Sustainable Design Can Be an Asset to the Bottom Line - expanded internet edition," *Environmental Design & Construction*, Posted 07/15/02. Available at: http://www.edcmag.com/CDA/ArticleInformation/features/BNP__Features__Item/0,4120,80724,00.html.

[21] Communication with Vivian Loftness, CMU, February 2003.

University. This represents ongoing research, and as such should be considered interim. [22]

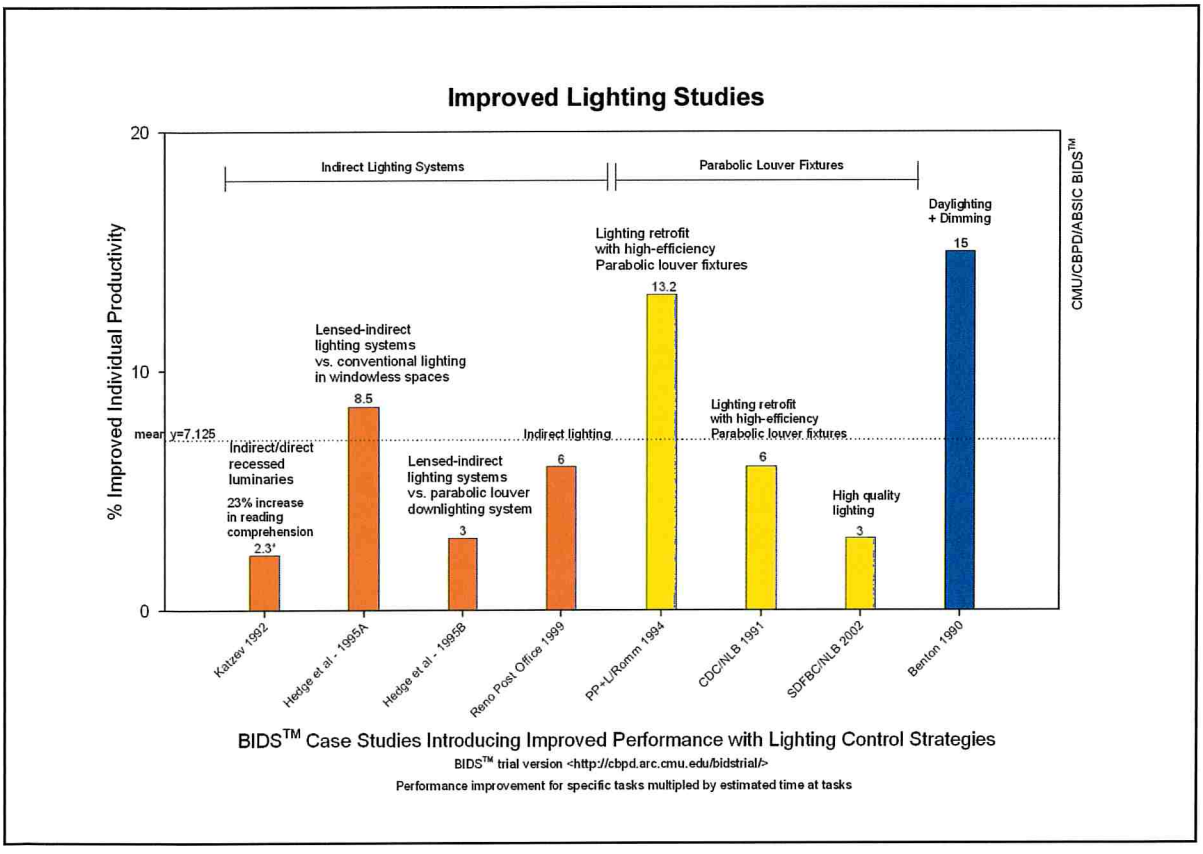
Improved Lighting Studies

A study by the Heschong Mahone Group evaluated the test score performance of over 21,000 students in three school districts in California, Colorado and Washington. The study found that in classrooms with the most daylighting, students' learning progressed 20% faster in math and 26% faster in reading than similar students in classrooms with the least daylighting.[23] A follow up study, employing an independent technical advisory group to reanalyze the data confirmed the initial study's findings with a 99.9% confidence level.[24]

At least four of the attributes associated with green building design – increased ventilation control, increased temperature control, increased lighting control and increased daylighting – have been positively and significantly correlated with increased productivity. There are also quantifiable green building gains in attracting and retaining a committed workforce – an aspect beyond the scope of this report.

Given the studies and data reviewed above, this report attributes a 1% productivity and health gain to Certified and Silver level buildings and a 1.5% gain to Gold and Platinum level buildings. These percentages are at the low end of the range of productivity gains for each of the individual specific building measures – ventilation, thermal control, light control and daylighting – analyzed above. They are consistent with or well below the range of additional studies cited above.

For state of California employees, a 1% increase in productivity (equal to about 5 minutes per working day) is equal to $665 per employee per year, or $2.96/ft^2 per year.[25] A 1.5 % increase in productivity (or a little over seven minutes each working day) is equal to $998 per year, or $4.44/ft^2 per year. The PV of the productivity benefits is about $35/ft2 for Certified and Silver level buildings, and $55/ft^2 for Gold and Platinum level buildings. Assuming a longer building operational life, such as 30 or even 50 years, would result in substantially larger benefits.



[22] Data extracted from BIDS™. Carnegie Mellon University Department of Architecture. February 2003.

[23] Heschong Mahone Group, "Daylighting in Schools: An Investigation into the Relationship Between Daylight and Human Performance," 1999. Available at: http://www.h-m-g.com

[24] Heschong Mahone Group. 2002. "Daylighting in Schools Re-Analysis." Available at: http://www.newbuildings.org/pier/index.html

[25] Average 2002 California employee compensation is $66,469 and average space per employee is 225 ft^2. Both numbers are discussed earlier in this section.

Operations and Maintenance

LEED requires measurement and verification and "Fundamental Building Systems Commissioning," which currently entails hiring a commissioning expert, developing a commissioning plan and completing a commissioning report.[26] Detailed analysis of several hundred million dollars of energy building upgrades demonstrate that rigorous measurement and verification of energy and water efficiency and system retrofits tend to[27]:

- Increase initial savings level
- Increase persistence of savings
- Reduce variability on energy and water savings

Commissioning and metering allows building staff to better manage upgrades and maintenance, helping to anticipate and avoid equipment failure, leaks and other costly operations and maintenance (O&M) problems.

O&M costs in California state buildings are about $3,000 per person per year[28] or nearly ten times larger than energy costs. There is not enough data to estimate with any precision the reduction in O&M costs that would occur in green buildings. This analysis conservatively assumes that green buildings experience an O&M cost decline of 5% per year. This equals a savings of $0.68/ft^2 per year, for a 20-year PV savings of $8.47/ft^2.

Valuing Green Buildings

Pension funds are beginning to recognize that green and energy efficient design can provide higher return, greater asset appreciation and lower risk to their real estate holdings. Notably, Phil Angelides, California Treasurer, recently announced that $1.5 billion (1-2%) of the state pension funds may be shifted to invest in more environmental and greener technologies.[29] For pension funds and real estate owners, high performance and energy efficient buildings can provide higher net operating margins, increased asset value and lower risk.

Can we develop this argument for private entities? Public institutions, including cities, states and local entities can also potentially gain a great deal from increasing the portion of new construction and retrofits of existing buildings to meet green standards. These benefits may include:

- Lower operating costs
- Lower peak demand and reduced pressure on transmission and distribution systems, including lower line losses and avoided or delayed construction;
- Improved power quality and reliability
- Reduced emissions (including NO_X and particulates) both from lower energy use and lower peak and consequently lower use of sometimes relatively dirty peaking and back up power
- Lower water use and water treatment and avoided or delayed required investment in water treatment and supply costs
- Improved health and productivity of occupants, including student test performance on standard tests
- Greater grid-wide and system reliability and security

Tools that public institutions can use or have used include accelerated permitting, allowing increased density of construction – floor area ratio (FAR) and permitting increased construction density around public transport nodes (metro stops) and corridors (bus lines).

Lawrence Berkeley National Laboratory has mapped approximately 80 energy efficiency and renewable energy measures onto specific "lines" of insurance benefited by their use.[30] Of the 64 LEED points possible in Design Areas 1-5 (excluding the Innovation and Design Process category, which is non-specific), 49 (77%) are associated with measures that have potential risk-management. Doing so would increase the recognized financial benefits of green design.

Conclusions

Most benefits described in this report, including lower energy and water costs, lower operations and maintenance costs, some waste reduction benefits and most health and productivity benefits accrue to owner occupants of buildings. For non-occupying owners, many of these benefits may not be experienced. As the brand value of LEED buildings increase, builders may be more likely to expect to have their green building investment translate into higher occupancy, higher lease rate, lower operations and maintenance costs and/or higher asset value.

This report began with an aggregation of data on actual or modeled costs for 40 green buildings. Largely derived from several dozen conversations with architects, developers and a literature search, the data indicates that the average construction cost premium for green buildings is about 2%, or about $4/ft^2, substantially less than is generally perceived.

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[26] See www.ipmvp.org. For purposes of disclosure, the principal author of the present report, Greg Kats, co-founded the IPMVP and served as its Chairman until 2001.

[27] Greg Kats, Art Rosenfeld, and Scott McGaraghan, "Energy Efficiency as a Commodity: The Emergence of a Secondary Market for Efficiency Savings in Commercial Buildings," *1997 ECEEE Conference Proceedings*. Available at: http://www.ipmvp.org/info/ccc397.pdf

[28] Data provided by the California Department of General Services, Real Estate Services Division, December 2002.

[29] See: http://sanjose.bizjournals.com/sanjose/stories/2004/02/02/daily30.html

[30] Edward Vine, LBNL Report No. 41432, 1998. Available at: http://eetd.lbl.gov/insurance/LBNL-41432.html. Extensive discussion and references on the subject can be found at http://eetd.lbl.gov/ea/mills/insurance/cifram.html.

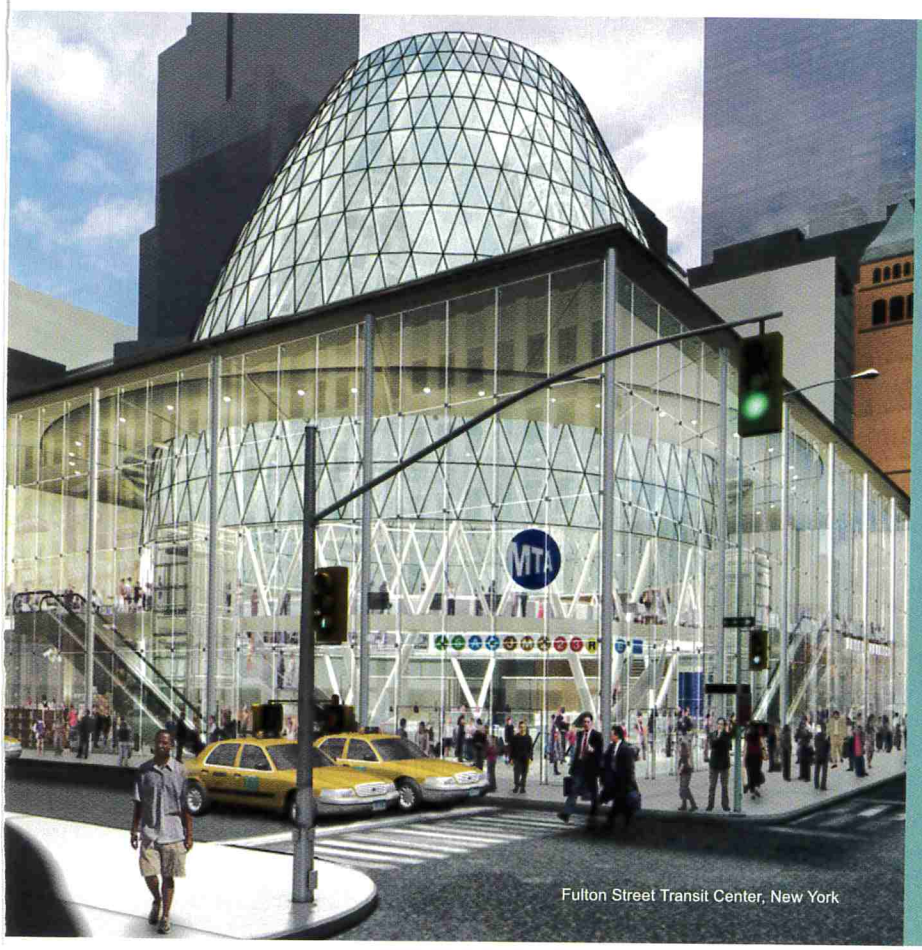
Summary of Findings (per ft²)

Category	20-year NPV
Energy Value	$5.79
Emissions Value	$1.18
Water Value	$0.51
Waste Value (construction only) - 1 year	$0.03
Commissioning O&M Value	$8.47
Productivity and Health Value (Certified and Silver)	$36.89
Productivity and Health Value (Gold and Platinum)	$55.33
Less Green Cost Premium	($4.00)
Total 20-year NPV (Certified and Silver)	**$48.87**
Total 20-year NPV (Gold and Platinum)	**$67.31**

Source: Capital E Analysis

As summarized above, net financial benefits of green design are estimated to be about $50/ft² for Certified and Silver level green buildings, and about $65/ft² for Gold and Platinum level buildings. This is over ten times larger than the average 2% cost premium (about $4/ft²) for the 40 green buildings analyzed. Despite gaps in data and analysis, the findings of this report point to a clear conclusion: building green up to and including the LEED Gold level generally makes financial sense today.

Gregory H. Kats *is cofounder and Principal of Capital E (www.cap-e.com) a national clean energy and green development services company. Mr. Kats served as the Director of Financing for the billion dollar Office of Energy Efficiency and Renewable Energy at the U.S. Department of Energy (1996-2001), the country's largest clean energy technology development and deployment program. Mr. Kats serves as Chair of the Energy and Atmosphere TAG for LEED and is on the LEED Steering Committee. Earlier in his career, he served in various marketing and sales management positions for Reuters Europe, Middle East and Africa, based in Paris, Geneva and then London, including European Marketing Manager. Mr. Kats served on the Parliamentary Committee on Environmental Sustainability in the UK House of Lords and as Advisor to the Environment Committee of the Hungarian Parliament. He earned an MBA Stanford University and concurrently, an MPA from Princeton University. Mr. Kats serves on a half dozen corporate and public boards, and lectures widely on green buildings, energy, financing and environmental issues. He is also helping to manage $600 million in green low-income housing.*



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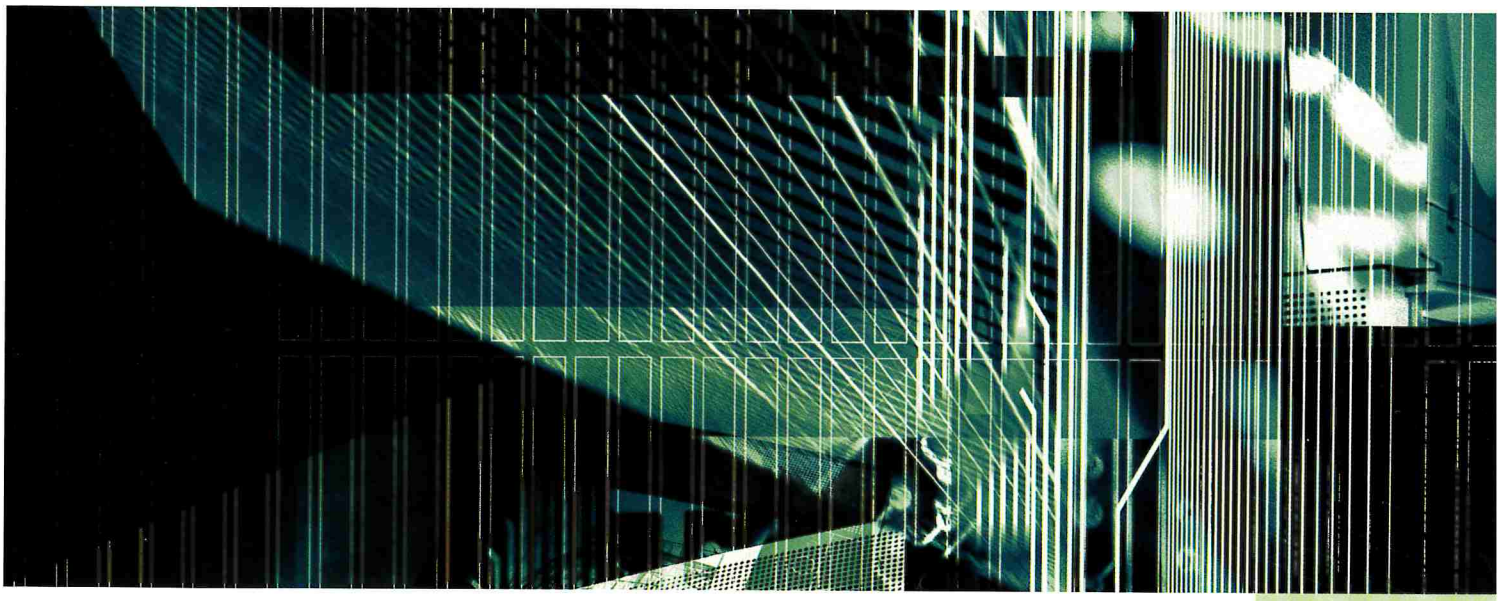


EXAMINING THE COST OF GREEN

Ethan Burrows and Lisa Matthiessen
Davis Langdon

The following is a summary of a comprehensive study on the cost of sustainable design (Costing Green – Comprehensive Cost Database and Budgeting Methodology, available for download at http://www.davislangdon-usa.com/publications.html).

This report compares the construction cost of green buildings to comparable buildings without sustainability goals, and analyzes incremental costs over starting budgets. Factors which influence cost and feasibility are examined, and a budgeting methodology is provided to help achieve the building's sustainability and program goals.

Many projects achieve sustainable design within their initial budget, or with very small supplemental funding. Owners are finding ways to incorporate project goals and values, regardless of budget, by making choices. There is no one-size-fits-all answer. Each building project is unique and should be considered as such.

More in-depth cost comparisons and information are available in the comprehensive report, including a point-by-point comparison of costs and feasibility for all projects studied. It also provides an introduction to the knowledgebase of cost information used to provide the project information for this study.

A Measure of Sustainability

The United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) rating system is useful for gauging the level of sustainability, or 'greenness' in a building. Thus, in order to answer the question of the cost of sustainable design, we can examine the costs involved in meeting each level of LEED certification when compared to non-LEED buildings.

The USGBC developed the LEED rating system as a measure to assess the sustainability of buildings in the United States. Using a point system, project teams identify sustainable design measures that can be incorporated into the project, and self-evaluate their success in doing so. If the building meets certain qualifications, it is recognized, with certification levels of Certified, Silver, Gold, or Platinum. The highest levels of certification (Gold and Platinum) are intended to require significant effort and ingenuity on the part of the project owners and designers, challenging them to push the boundaries and create highly efficient, sustainable buildings to serve as examples, and push market transformation.

LEED provides a means to actually measure sustainability using accepted standards and methodologies, and often using cost and quantities as determinants. It therefore lends itself to statistical analysis. Also, LEED has effectively become the accepted standard for measuring green design in the United States; most project teams have the basic knowledge allowing them to understand the implications of the analysis undertaken here.

Analyzing the Data – Cost Analysis of Similar Buildings

To compare construction costs of buildings where LEED certification was a primary goal, to similar buildings where LEED was not considered during design, we selected 45 library, laboratory and academic classroom projects which were designed with a goal of meeting some

level of the USGBC's LEED certification, and compared them to 93 non-LEED buildings with similar program types. All costs were normalized for time and location in order to ensure consistency for the comparisons.

In a comparison between all projects, something interesting came to light: the cost per square foot for the LEED-seeking buildings was scattered throughout the range of costs for all buildings studied, with no apparent pattern to the distribution. Sample variation analysis tests indicated that there was no statistically significant difference between the LEED population and the non-LEED population. In other words, any variations in the samples, or the sample averages, were within the range to be expected from any random sample of the whole population. It is important to note, however, that the standard deviation in dollars per square foot cost for each category (LEED-seeking and non-LEED) was quite high, since there is such a wide variation in building costs.

LEED-Seeking versus Non-LEED

Throughout these comparisons, we have referred to the two groups as LEED-seeking and non-LEED. However, it is important to keep in mind that the difference between these groups is simply that the LEED-seeking buildings were designed with LEED certification in mind, while this was not one of the goals for the non-LEED buildings.

To compare LEED-seeking to non-LEED buildings, ten non-LEED buildings were selected at random from the 93 examined for this study. A LEED checklist was created for each of these ten buildings to determine the number and type of points each project would receive with their current design.

This analysis concluded that these non-LEED projects achieved between 15 and 25 points with their established designs, and in fact, one project was estimated to qualify for 29 points – enough to earn a rating of LEED Certified if the building owners had so desired.

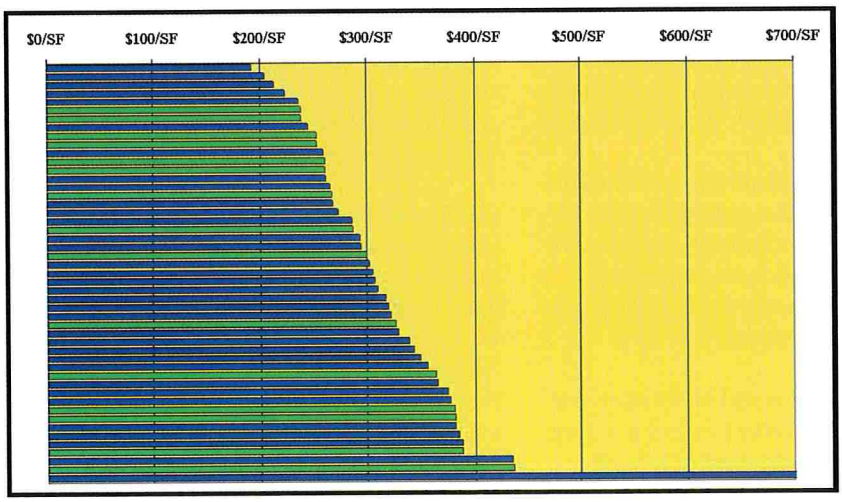
Closer examination of the non-LEED and LEED buildings suggests that for any building, there are usually about 12 points that can be earned without any changes to design, due simply to the building's location, program, or requirements of the owner or local codes. Up to 18 additional points are typically available for a minimum of effort, and little or no additional cost required.

Cost Analysis of Similar Buildings – Conclusion

Our findings show that projects are achieving LEED within the same cost range as non-LEED buildings.

However, it does not necessarily follow that a specific individual building will be able to achieve LEED at no added cost. Rather, the data suggests that there are many factors affecting cost in a building, and that LEED tends to have a lesser impact on the bottom line than other factors.

Comparisons of buildings by category were also done, and are presented in more detail in the complete report, including graphs such as the one shown below.



Blue:
$/sf Non-LEED Buildings

Green:
$/sf LEED Buildings

LEED Seeking vs. Non-LEED

To summarize the findings in these category comparisons, we found that there was no significant difference in the construction costs for LEED-seeking versus non-LEED buildings in any of the categories. The only exception was seen when comparing branch libraries (libraries that were less than 40,000 total square feet). In the sample studied, the LEED-seeking buildings were statistically less expensive to build than non-LEED buildings.

Analyzing the Data – Initial Budget

One of the most common methods used to establish the cost of green, has been to compare the final construction costs for the project to the established budget. In other words, was the budget increased to accommodate the sustainable elements, or were those elements incorporated into the project within the original available funds? Within the LEED-seeking buildings we studied, we found that over half the projects had original budgets that were set without regard to sustainable design, and yet received no supplemental funds to support sustainable goals. Of those that did receive additional funding, the supplement was usually provided only for specific enhancements or requirements, such as photovoltaic systems, and the range of monies supplemented, for those few that required it, was typically in the range of 0–3% of initial budget.

The projects that were the most successful in remaining within their original budgets were those which had clear goals established from the start, and which integrated the sustainable elements into the project at an early stage. Projects that viewed the elements as added scope, tended to experience the greater budget difficulties.

From this analysis we can conclude that many projects can achieve sustainable design within their initial budget, or with very small supplemental funding. This suggests that owners are finding ways to incorporate the elements important to the goals and values of the project, regardless of budget, by making choices and value decisions.

Feasibility and Cost

While in general LEED projects fall within the same cost range as non-LEED projects, it is also true that individual projects experience differences in LEED costs. Davis Langdon's analysis includes a breakdown of feasibility by LEED point. The following factors can greatly influence the cost of green.

Intents / Values: Perhaps the single most significant factor in determining the feasibility of incorporating sustainable design into a building, is the established intent and values of the building owner and project team. The best and most economical sustainable designs are ones in which the features are incorporated at an early stage into the project, and where the features are integrated, effectively supporting each other, and the owner has the ability and willingness to make decisions affecting aesthetics and operations in the interest of sustainability. If the owner has no expressed desire to incorporate elements of sustainable design, it becomes more difficult to incorporate the necessary modifications into the design.

This underscores the importance of understanding the actual intents and desires of the owner and the design team. If they are not actually serious, or are unwilling to invest the time and cooperation that may be needed, it will be much more difficult to reach the desired level of sustainability. This is likely to impact cost to build.

Bidding Climate: Another of the key factors in the cost of sustainable design is the response of bidders to the green requirements in the contract. There are some measurable direct costs to be borne by the contractor, including the cost of documentation of the material credits, the application of the construction indoor air quality credits, and some of the schedule impacts of post construction building flush-out. These, however, are relatively low costs.

A far greater impact comes where the contractor perceives the sustainable requirements as onerous or risky. Some construction contracts include phrases that transfer the liability for achieving LEED certification to the contractor. Clearly the contractor, when faced with this requirement, will include a greater risk contingency into their bid, if they are willing to bid at all. In order to manage the impact of sustainable design on bid response, it is necessary to write reasonable specifications and contracts, and to engage the contractor in a collaborative process, possibly even including training and bonuses for compliance, rather than transferring risks and applying penalties for failure.

In areas where bidders are unfamiliar with building sustainable projects, they are likely to be more wary. This has two effects: firstly, bidders are inclined to add contingencies or risk premiums to cover the perceived risk; secondly, the bid pool diminishes, leading to poorer competition and higher bid prices. As bidding communities become more familiar with sustainable buildings, the risk premiums decrease, and the competition increases, reducing or eliminating the green premium.

The cost impact of bid climate is more pronounced when bidders have plenty of alternative work. When work is scarce, bidders are more willing to discount the risk in order to remain in business. For this reason it is essential to understand the bid community and the work availability.

Demographic Location: The location of the project can have a significant impact on the cost and feasibility of some sustainable design elements. For example, urban redevelopment and accessibility to alternate forms of transportation (such as bus lines) would only be available in urban settings. Rural sites would likely include larger areas of green space around the building. This would improve the ability of the project to earn the stormwater management points.

The ability of a project to take part in construction waste management points is also impacted by the selection of the urban versus the rural setting. In

urban environments there is more likely to be well-established construction waste recycling or reclamation programs. Additionally, contractors are more likely to be familiar with these practices.

Climate: The climate where the building is to be constructed can play a key role in whether or not the project can actually achieve certain LEED points, as well as the cost to achieve particular LEED ratings. For example, since the LEED points for energy usage are based on the cost of energy saved, the relative cost of heating and cooling energy in each market can have an impact on the effectiveness of energy economy measures. This underscores the need to understand the climate and the energy costs where the building will be located. Yearly temperature fluctuations and levels of humidity can play a significant role in determining costs for mechanical systems, as well as whether or not the project may be able to use passive heating or cooling instead of relying on a mechanical system.

Conclusion: There are a number of factors which can have a significant impact on both the ability to achieve specific LEED points, and on the cost to build a sustainable building. When considering cost and feasibility for pursuing LEED certification for any building, it is extremely important to:

- Understand the feasibility of each point for the project
- Understand the factors affecting cost and feasibility

Having a comprehensive understanding of these factors allows an owner to more accurately determine potential costs, and to make better choices as to which LEED points to pursue.

Budgeting Methodology for Green

When establishing a design and a budget for a LEED building, the key point to remember is that sustainability is a program issue, rather than an added requirement. Our analysis indicates that it is necessary to understand the project goals, the approach to achieving the goals, and the factors at play in the project. This must be done as early as possible in the project and it must be considered at every step of design and construction.

The first question in budgeting should not be "How much more will it cost?", but "How will we do this?"

Establish Team Goals, Expectations and Expertise

When considering sustainability, it is important to understand your team. The feasibility and potential cost impact of a number of LEED points can be significantly increased or decreased by whether or not the members of the design and construction teams are familiar with sustainable practices, and willing to commit to following established protocols and procedures.

It is also important to ensure that the team includes the expertise that will be necessary to allow the sustainable elements to be incorporated smoothly. You must align the goals and values of the project such that all members of the team accept and understand them.

Include Specific Goals

A LEED checklist should be prepared at the start of the project and at every program stage. This will enable the project team to clearly understand their current ability to meet the project's established goals and values. Additionally, the team should specify design measures to be employed in meeting the goals, and these should be routinely monitored to ensure full compliance.

It may seem impractical to develop a sustainable design strategy during the program stage of design, when so little of the building is defined. It is our experience, however, that many of the features can be identified, visualized and incorporated into the cost model if sufficient attention is paid to them.

Align Budget with Program

It is essential to align the budget with the program during the programming phase of the project. If there are insufficient funds to fulfill all of the program goals, either the goals must be reduced, or the budget increased. Too often projects move forward with a mismatch, either because the project team is unaware of the mismatch, or (more often) due to wishful thinking that something will turn up to resolve the problem.

In order to align the budget with the program, a cost model should be developed which allocates the available funds to the program elements. The program will dictate the majority of the cost elements, both in quantity and quality, and from that it is possible to build a cost model, even when design information is limited. The cost model will both reflect the program – highlighting areas of shortfall – and provide planning guidance for the design team by distributing the budget across the disciplines. The cost model also provides a communication tool for the project team, allowing clear understanding of any budget limitations. These must be addressed by adjusting scope, design or funds. Proceeding with inadequate funding will lead to more drastic scope reductions at later stages in the design process, and greater conflict between competing interests in the program. It is in these cases that sustainable elements are most vulnerable to elimination as unaffordable expenses.

It is the choices made during design which will ultimately determine whether a building can be sustainable, not the budget set.

Stay On Track

Once you have a clear understanding of the goals and values for the project, as well as the budget available, it is important to stay on track throughout the entire process. The steps for staying on track include beginning and maintaining any necessary documentation, updating and monitoring the LEED checklist, and using energy and cost models as design tools, preferably early in design.

Budgeting Methodology – Conclusion

The only effective way to budget for sustainable features within buildings is to identify goals, and build an appropriate cost model for them. If they are seen as upgrades or additions, the cost of sustainable elements will also be seen as an addition. It is possible to establish goals and budgets from the very beginning of the project. Any assessment of the cost of sustainable design for a particular building must be made with reference to that building, its specific circumstances and goals.

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Lisa Matthiessen, *AIA, LEED AP, is a Senior Associate at Davis Langdon and has extensive experience in implementing sustainable design goals. Ms. Matthiessen was the project architect for the greening of the Donald Bren School for Environmental Science and Management at University of California, Santa Barbara, the first platinum LEED project in the State. She was responsible for design analysis, development of greening measures complete with budget and schedule implications, implementation of selected measures, and LEED documentation. At the Natural History Museum of Los Angeles, Lisa was responsible for project planning, including open architectural competition for design architect, creation of master budget and schedule, team formation and contract negotiations, preparation of documents for use in design and management of the master plan process for the project, which is targeting LEED Platinum. She has been involved in many sustainable projects including: the Yosemite Lodge Redevelopment, the Evergreen Valley College Arts Center in San Jose, Cooper Union, and various Los Angeles Community College District projects - all LEED Certified/Silver, with energy and renewable energy requirements above and beyond LEED. Lisa was the Founding Chairperson of the US Green Building Council, Los Angeles Chapter and is the Co-Chair of the AIA Committee on the Environment (COTE), Los Angeles Chapter.*

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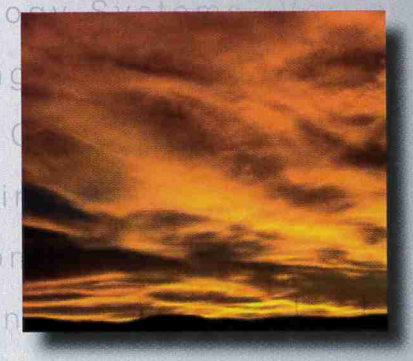

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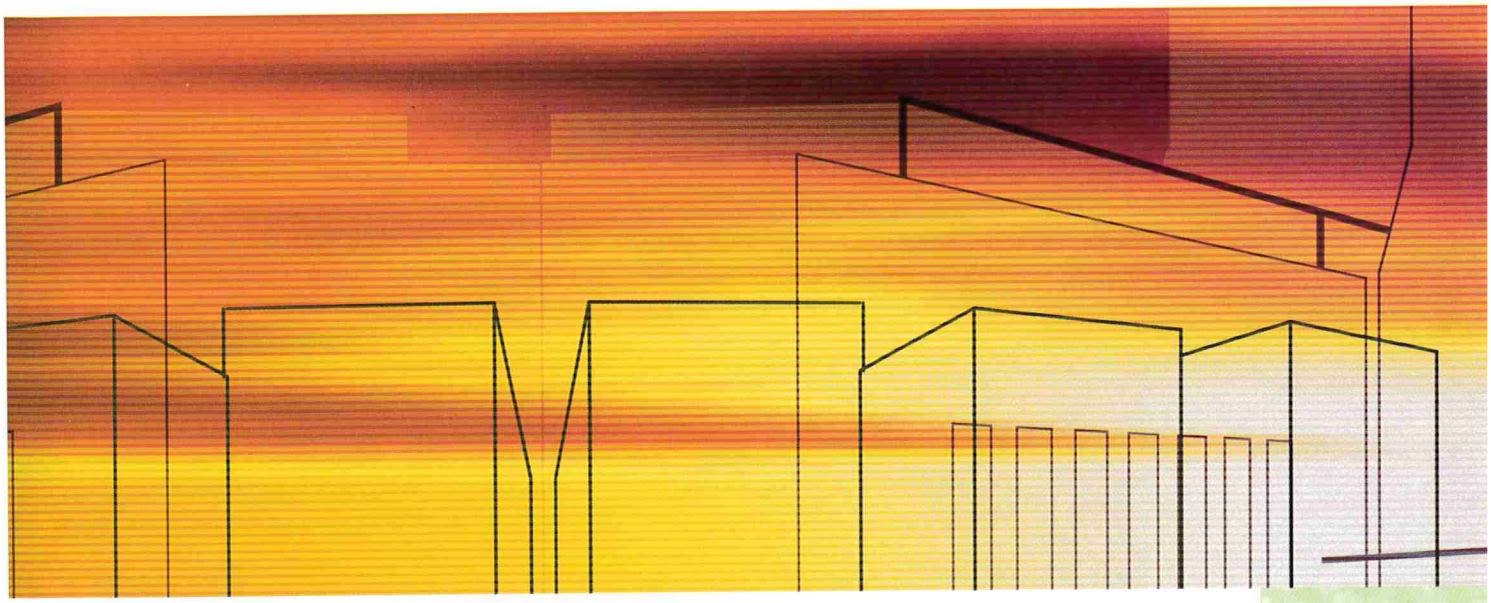

DEFINING LEED® COSTS FOR THE U.S. GENERAL SERVICES ADMINISTRATION

John Amatruda, RA
Steven Winter Associates, Inc.

The following article has been adapted from the Executive Summary of the U.S. General Services Administration (GSA) LEED Cost Study, which was developed by Steven Winter Associates, Inc., with cost estimating provided by Skanska USA Building, Inc. The full content of the GSA LEED Cost Study is available at the Whole Building Design Guide website, www.wbdg.org.

The US Green Building Council's *Leadership in Energy and Environmental Design* (LEED®) Building Rating System provides a well-defined, rigorous standard for high performance projects. For many building owners, institutions, or municipalities that are considering green projects or a green building program, the perceived "cost of LEED" is a key determinant of their overall comfort level and project commitment.

Because of this broad and pressing interest, a number of "green" cost studies have been developed in the past several years, with many focused specifically on the costs of LEED-rated projects[1]. In addition to the studies, a significant number of LEED certified buildings have recently been completed, providing a growing body of anecdotal evidence on green building costs.

Surprisingly, despite this concentration of recent information, the existing evidence has not provided a consistent, consensus answer on the issue. Rather, the studies and individual building projects have demonstrated a range of cost impacts – from first cost savings to high additional costs – which imply that the answer to the question of green costs is inherently complex.

For the US General Services Administration (GSA), one of the largest building owners and managers in the nation, the issue of sustainable design costs has been particularly relevant. As of fiscal year 2003, GSA has mandated that all of its new construction and major modernization projects be certified through the LEED program, with an emphasis on obtaining Silver ratings. With this level of commitment to sustainable design, GSA has had a clear need to address the associated costs and benefits. While GSA had previously developed a study to estimate general green building costs, the agency had not specifically addressed costs related to LEED-rated buildings. GSA therefore commissioned a new "LEED Cost Study" to update the agency's understanding of green building costs and to align their cost assumptions with the latest LEED criteria (Version 2.1).

GSA's approach to defining green costs was structured and methodical, and was intended to define a process, as well as produce answers. The study (as described below) defines distinct building "baselines", to which various green building measures (design features, equipment upgrades, material substitutions, etc.) are added, based on applicable LEED criteria. The trans-

[1] Examples include: "Green City Buildings" by Xenergy Inc./SERA Architects (2000); "Packard Foundation Los Altos Project" by BNIM Architects and others (2002); "Costs and Financial Benefits of Green Buildings" by Greg Kats, Capital E (2003); and "Costing Green, A comprehensive Cost Database and Budgeting Methodology" by Davis Langdon (2004).

parency of the baseline building assumptions, as well as the added "green" building features, provides a basis for other users to compare the GSA cost impacts to their own projects.

The GSA LEED Cost Study

The GSA LEED Cost Study specifically reviews the first cost implications of achieving Certified, Silver, and Gold LEED ratings for two GSA building types, using GSA's established design standards as the point of comparison.[2]

The two building types examined in the study are:

1. A new mid-rise federal Courthouse (five stories, 262,000 GSF, including 15,000 GSF of underground parking; base construction cost is approximately $220/GSF).

2. A mid-rise federal Office Building modernization (nine stories, 306,600 GSF, including 40,700 GSF of underground parking; base construction cost is approximately $130/GSF).

These building types reflect a significant percentage of GSA's planned capital projects over the next five to ten years.

Construction Cost Impacts

For each of the two building types, baseline construction cost estimates were developed to reflect applicable federal design requirements, as defined in GSA's Facilities Standards for the Public Building Service (Document PBS-P100, 2003), and, for courthouses, the Administrative Office of the United States Courts' US Courts Design Guide. The design standards were also used as the basis for evaluating each LEED prerequisite and credit.

An analysis was performed to identify green building measures – above and beyond those included in GSA's standards – that would likely be implemented to meet the specific LEED prerequisite and credit requirements. From these measures, cost impact estimates were developed for each prerequisite and credit, with variations defined for both the Courthouse and Office Building models. Once defined, the individual credit costs were also categorized, using the following key:

1. GSA mandate (no cost)
2. No Cost/Potential Cost Decrease
3. Low Cost (< $50K)
4. Moderate Cost ($50K-$150K)
5. High Cost (>$150K)

From these individual credit assessments, overall project cost estimates were developed for 12 LEED rating "scenarios" (six for each building type). The scenarios were defined as follows:

- New Courthouse: Two estimates were developed at the Certified, Silver, and Gold rating levels. At each level, one "low cost" and one "high cost" scenario was defined in order to bracket the LEED costs.

- Office Building Modernization: Two estimates were developed at the Certified, Silver, and Gold rating levels. At each rating level, one scenario reflected a "minimal façade renovation" (window replacement, minor repairs) and the other reflected a "full façade renovation" (new cladding and façade design, new windows, new insulation). The different façade scenarios reflect one of the most significant scope variations in GSA's modernization projects, and were therefore used as the basis for bracketing the LEED Office Building costs.

In developing each rating scenario, cost synergies were identified among related credits. In this way, strategies or systems that applied to more than one credit (e.g., carbon dioxide sensors used to monitor indoor air quality and to provide demand control ventilation to reduce energy use) were correctly accounted for (i.e., the specific green system, equipment or material costs were not counted more than once).

The point totals used for each rating level were as follows: 28 points for a Certified rating, 35 points for a Silver rating, and 41 points for a Gold rating. These totals are purposely two points higher than the LEED minimums, as it is common practice to submit additional credits to ensure that a rating is achieved (i.e., in the case that one or two credits are denied during the LEED certification process with the USGBC).

The construction cost estimates reflect a number of GSA-specific design features and project assumptions; the summary numbers should be used with caution. As with any project-specific estimate, simple cost extrapolations from the overall results cannot be considered reliable for projects of significantly different scope or scale. For most project teams, the detailed cost breakdowns included in the LEED Cost Study will be more useful as a basis for evaluating LEED costs. The "apples to apples" comparisons included in the full report can serve as a starting point in understanding the typical scope and potential cost implications of various LEED measures.

The overall results do, however, begin to define a range of cost impacts that can be used to gauge LEED cost premiums for similar projects. The range of the cost results warrants further explanation, as follows.

[2] The full study also includes soft cost estimates for LEED projects; however, these are not addressed in this article.

Addressing LEED Cost Variations

As demonstrated through the "bracketed" results of Tables 1A and 1B, the study indicates there is an inherent degree of variability to LEED construction cost impacts. This is consistent with the range of cost impacts reported through other studies, and through the anecdotal evidence of completed LEED projects. In the case of the LEED Cost Study results, the primary factors creating this variability were identified as follows:

1. *There is no correlation between the point value of a LEED credit and its cost.* There are many "no cost" and "low cost" LEED credits (such as development density, proximity to public transportation, no irrigation systems, use of locally manufactured materials, low-VOC adhesives, low-emission carpets) that earn one point each. At the other extreme, the study illustrates that some credits (renewable energy, for example) can cost hundreds of thousands of dollars each – and still earn one point. The selection of credits used to achieve a LEED rating can therefore result in a wide range of resultant costs.

2. *A range of different strategies can often be used to earn the same individual LEED credit.* Many of the LEED credit criteria are performance based rather than prescriptive. This allows design teams flexibility in defining an approach to credit compliance. Different strategies can also result in significantly different cost impacts. An example from the cost study is credit SS-6.1, Stormwater Management (reduce stormwater runoff by 25%), used in the Courthouse model. In the "low cost" scenarios, the credit was earned by increasing the amount of site plantings and reducing the amount of site paving. This approach actually reduced construction costs. In one of the "high cost" Gold rating scenarios, a vegetated roof system was installed as an alternative approach. The premium for the vegetated roof system was approximately $580,000. While the vegetated roof has additional benefits and was used to earn an additional LEED credit (SS-7.2, Heat Island Reduction), it still represented a significantly more expensive approach to credit compliance.

The construction cost impacts for the 12 rating scenarios are identified in Tables 1A and 1B.

TABLE 1A*

	NEW COURTHOUSE (262,000 GSF, Base Construction Cost = $220/GSF)					
	Certified		Silver		Gold	
	1A Low Cost	2A High Cost	3A Low Cost	4A High Cost	5A Low Cost	6A High Cost
LEED CONSTRUCTION COST IMPACTS:						
$/GSF	($0.76)	$2.18	($0.07)	$9.57	$2.97	$17.79
% CHANGE	-0.4%	1.0%	-0.03%	4.4%	1.4%	8.1%

TABLE 1B*

	OFFICE BUILDING MODERNIZATION (306,600 GSF, Base Construction Cost = $130/GSF)					
	Certified		Silver		Gold	
	1B Min. Facade	2B Full Facade	3B Min. Facade	4B Full Facade	5B Min. Facade	6B Full Facade
LEED CONSTRUCTION COST IMPACTS:						
$/GSF	$1.78	$2.73	$3.96	$5.58	$10.60	$10.25
% CHANGE	1.4%	2.1%	3.1%	4.2%	8.3%	7.8%

* Construction cost estimates reflect a reference date of October 2003 (GSA FY04) and a reference location of Washington, DC.

3. *The cost of some credits varies significantly based on the building type and building program.* For example, in the Office Building model, earning credit MR-7 (Certified Wood) involved a moderate cost premium (approximately $77,000) because wood use in the building was limited (some doors and a small amount of casework). In the Courthouse model, on the other hand, the cost premium to earn the credit was almost $600,000. The Courthouse has extensive wood finishes, including paneling, doors, casework, and fixed furnishings in the courtrooms and judges' chambers.

4. *Some credit costs vary based on region-specific or project-specific issues.* Two examples illustrate this point. In some parts of the country, earning and exceeding the requirements of credit MR-5.1/5.2 (Local/Regional Materials) can be easily accomplished at no cost. In other locations, a premium may be paid to use brick, stone, or other major construction materials that are locally manufactured or sourced. A second example involves credit MR-2.1/2.2 (Construction Waste Management). Costs to earn this credit can vary significantly depending on the recycling infrastructure in the region, the experience of the contractors and construction/demolition crews, and the space constraints of the project site.

Overall, the study illustrates that when GSA projects take advantage of many "no cost" or "low cost" credit opportunities, the overall construction cost premium can be surprisingly limited, even at the higher rating levels. Under certain conditions, it is even possible for projects to show a slight cost decrease. However, when few low-cost credits are available to a project, the premiums increase significantly. The level of variability is most clearly illustrated in the Gold rating scenarios of the Courthouse model, which ranged from only a 1.4 percent premium in the "low cost" case (approximately $3.00/GSF) to an 8.1 percent premium (almost $18/GSF) in the "high cost" case.

By contrast, the cost premiums for the Office Modernization model showed much less variation at each rating level. This was intentional to a large degree, because the cost bracketing was based primarily on one issue (the impact of the different façade renovations) rather than on the more extensive "low cost vs. high cost" approach used for the Courthouse. The Office Building model also demonstrated, however, that when the choice of LEED credits is more limited, the cost premiums tend to be more predictable. The Office Building model had fewer credits to choose from because the scope of work did not include site renovations or roof replacement, which limited the number of applicable

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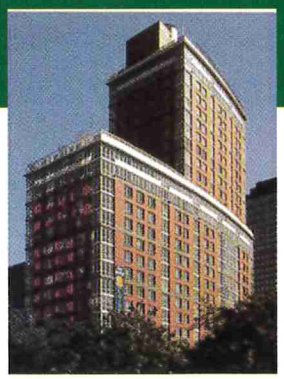

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Managing LEED Costs

Beyond the issue of cost variations, the broader implication derived from the Courthouse and Office Building models is that GSA's LEED costs can be managed, and to some degree predicted, if a consistent approach is applied from project to project. A similar process can be extrapolated for non-GSA projects as well. A structured approach to LEED would include the following steps:

- Identify and incorporate all LEED credits that are "automatically" earned based on the project's existing design criteria or building standards.
- Identify and incorporate those LEED credits that can be earned at no cost or minimal cost based on the particular site conditions and programmatic requirements of the specific project.
- Evaluate and incorporate appropriate no-cost or minimal-cost LEED credits. Examples include items such as water efficiency (plumbing fixtures) or low-emission paints, adhesives and sealants. Many of these credits do not affect the project design, but rather involve product selection and specification issues.
- Evaluate and select appropriate credits at the moderate and high-cost levels. Analysis of these credits should first weigh costs against the immediate and long-term value of the measures (e.g., lower operating costs, improved workplace environment, significant community or environmental benefits). At this level, a strong emphasis should be placed on identifying and exploiting inter-credit synergies.

An analysis of this type, performed early in the design process, can provide clear direction to a design team and help establish realistic LEED goals. In addition, the analysis can help teams identify the significant design and performance challenges for a project, which require integrated thinking and full team participation. These design-related issues often have the most significant impacts on cost and performance (e.g., approaches to daylighting, energy efficiency, stormwater management) and therefore require an early focus.

This structured approach is the basis of GSA's LEED Applications Guide, a companion document which is being developed to supplement the LEED Cost Study.

Conclusions

The GSA LEED Cost Study is the latest in a series of recent reports that attempts to assess the first cost impacts of green buildings. While the study is particular to GSA projects and GSA design issues, it provides a detailed, structured review of potential LEED cost impacts on a credit-by-credit basis. These detailed cost analyses can provide useful guidance to other projects, as a basis for assessing their own "baseline versus green building" costs. The study also demonstrates some of the reasons why reported green building costs seem to vary significantly, even when the same LEED rating level has been achieved. Finally, the GSA LEED Cost Study, and companion Applications Guide, define a general process that can be used to assess and manage LEED costs in the early stages of a project design.

John Amatruda *is an architect and Senior Associate at Steven Winter Associates, Inc. of Norwalk, Connecticut, where he specializes in environmentally conscious design and the evaluation of "green" materials and systems. Mr. Amatruda has worked as an architect and environmental consultant on numerous commercial and residential projects nationwide which feature energy-efficient design, detailed computer analysis of buildings and building details, environmental material selections, and whole building evaluations using the U.S. Green Building Council's LEED rating system. In addition to building-specific projects, Mr. Amatruda was the lead author of the "GSA LEED Cost Study", developed for the U.S. General Services Administration, and author of the "Green Products" Resource Page for the web-based Whole Building Design Guide. Mr. Amatruda is also a member of the USGBC's LEED Faculty. Prior to joining SWA, Mr. Amatruda was an Associate with William McDonough Architects in New York, where his projects included "green" facilities for the Rodale Press, Wal-Mart, and the Heinz Family Foundation.*

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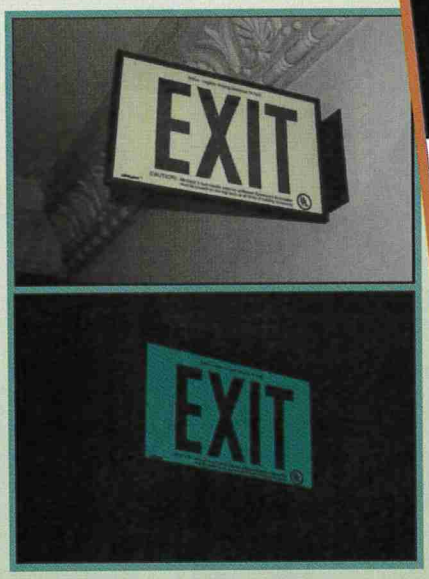

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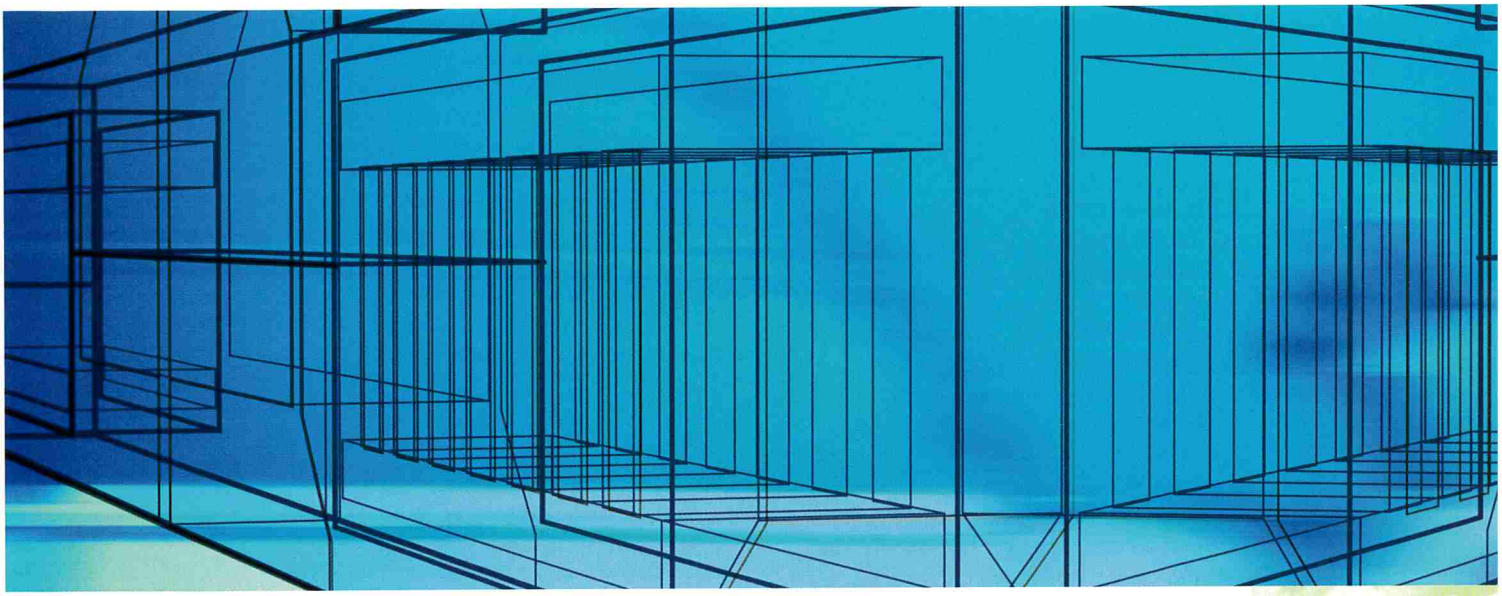


DEVELOPING LONG TERM COMPETITIVE VALUE: A PRIMER ON SUSTAINABLE DEVELOPMENT

Bert Gregory, AIA
Mithūn

This article is largely based on the Resource Guide for Sustainable Development in an Urban Environment. *A downloadable free copy is available at www.mithun.com*

Smart developers are taking advantage of the convergence of new environmental technology and a growing market for well-conceived sustainable properties for a healthier bottom line and a healthier community.

As recently as 10 years ago, we scrambled for dictionaries to look up the word sustainable. Today, smart developers know that building "green" makes a lot of sense, for increasing both the economic viability and long-term competitive value of projects. Now it is generally acknowledged that high-performing buildings lower environmental risks and increase appeal for institutional and owner-occupied clients alike, and are appropriate for single buildings, blocks, clusters of buildings, or even an entire neighborhood.

The Resource Guide for Sustainable Development in an Urban Environment provides rules of thumb for developers. It considers existing and future market conditions, investigates adaptations to traditional value equations and encourages ongoing dialogue. It helps developers connect good business sense with what is environmentally smart through a comprehensive, integrated approach, and by harnessing the strengths of existing site systems, including water efficiency, renewable energy, recycled and low emitting materials and indoor air quality. The goal is to help the entire development community build on the economic, environmental, community and marketing advantages of sustainability.

The power of integration

Sustainable development represents a recent and rapid evolution in thinking, and incorporates an iterative, integrated design strategy to improve the financial value equation. An integrated design team is inclusive and works closely together from the beginning of the project. Ideas for design solutions can come from any stakeholders in the project, including the facility manager, contractors and others. This opens the door for discovering creative concepts for optimum building performance; value is added to the project and the developer can save money by avoiding unexpected risks.

Here's an example: Raised floor air distribution systems can meet both wiring and thermal requirements that are typically handled separately by the electrical and mechanical engineers. When these two factors are also added to the benefits of lower energy costs and lower relocation costs in dynamic organizations, significant value can be created. When all team members are at the table during early discussions, these relationships become apparent and a wider range of ideas become possible.

Establish sustainable goals immediately

Many developers wait to commit to sustainable technologies until the value engineering phase is done. It's much better to establish sustainable goals on the first day of the project. Early exploration makes it easier

to capitalize on opportunities as the project proceeds. Many times sustainable goals can be synchronized with the minimum requirements of a project, which leaves openings for future expansion as decisions are solidified. This approach typically allows for a much greater range of goals to be met. When goals are not established at the outset of the project and are then added later, critical decision-making points for structural, mechanical or site systems have often already passed.

Take advantage of whole-building and whole-system design

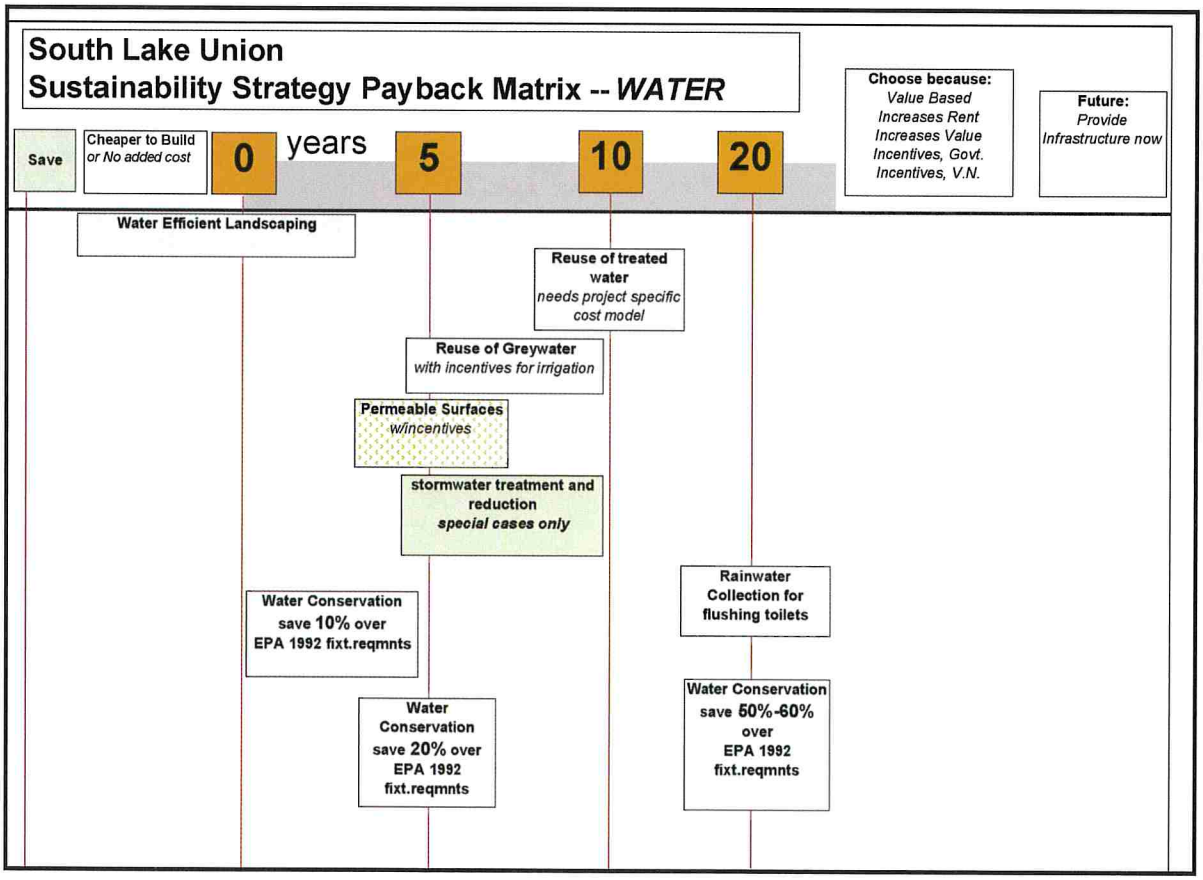
Integrated design means looking at the whole building or, in the case of a neighborhood, whole natural systems, in order to take advantage of relationships. In this way the whole can become greater than the sum of its parts. One way of supporting a whole system design approach is to hold a "charette," a concentrated, all-team meeting where each person is encouraged to think beyond their area of expertise, emphasizing the interdependency of various roles. A charette accelerates the education process, helps solidify stakeholder buy-in, diminishes tension, uncovers nuances and typically expedites the design process. The outcome is not necessarily a final solution, but rather a shared understanding of the project and permission to innovate as the team moves forward.

Reduce demand for scarce resources

Prioritize expenditures to reduce demand for energy, water and materials. For example, solar window shades on the south side of a building reduce the amount of electricity needed to run air conditioning and often results in less costly equipment sizes. This makes the project less vulnerable to fluctuating rates, and provides a competitive edge when jockeying for additional tenants or residents.

New energy solutions can also help reduce reliance on infrastructure. Digital technology is radically improving the efficiency of power conversion devices of all types, such as the use of LEDs for lighting. It is also creating a demand for high quality, highly reliable power to keep electronic equipment running smoothly. As the Electric Power Research Institute (EPRI) noted recently, "U.S. business activity is becoming more reliant on digital circuitry and more sensitive to incredibly minute variations in power supply – variation that would have gone unnoticed in years past." In fact, many high-tech industries require "high 9s" power, available 99.99 percent of the time.

Developers can therefore justify – and should charge a premium for – high-quality "reliable green" power. In



This matrix comparing return-on-investment of various sustainable water strategies is one of a series on energy, materials and sites that can help developers make choices.

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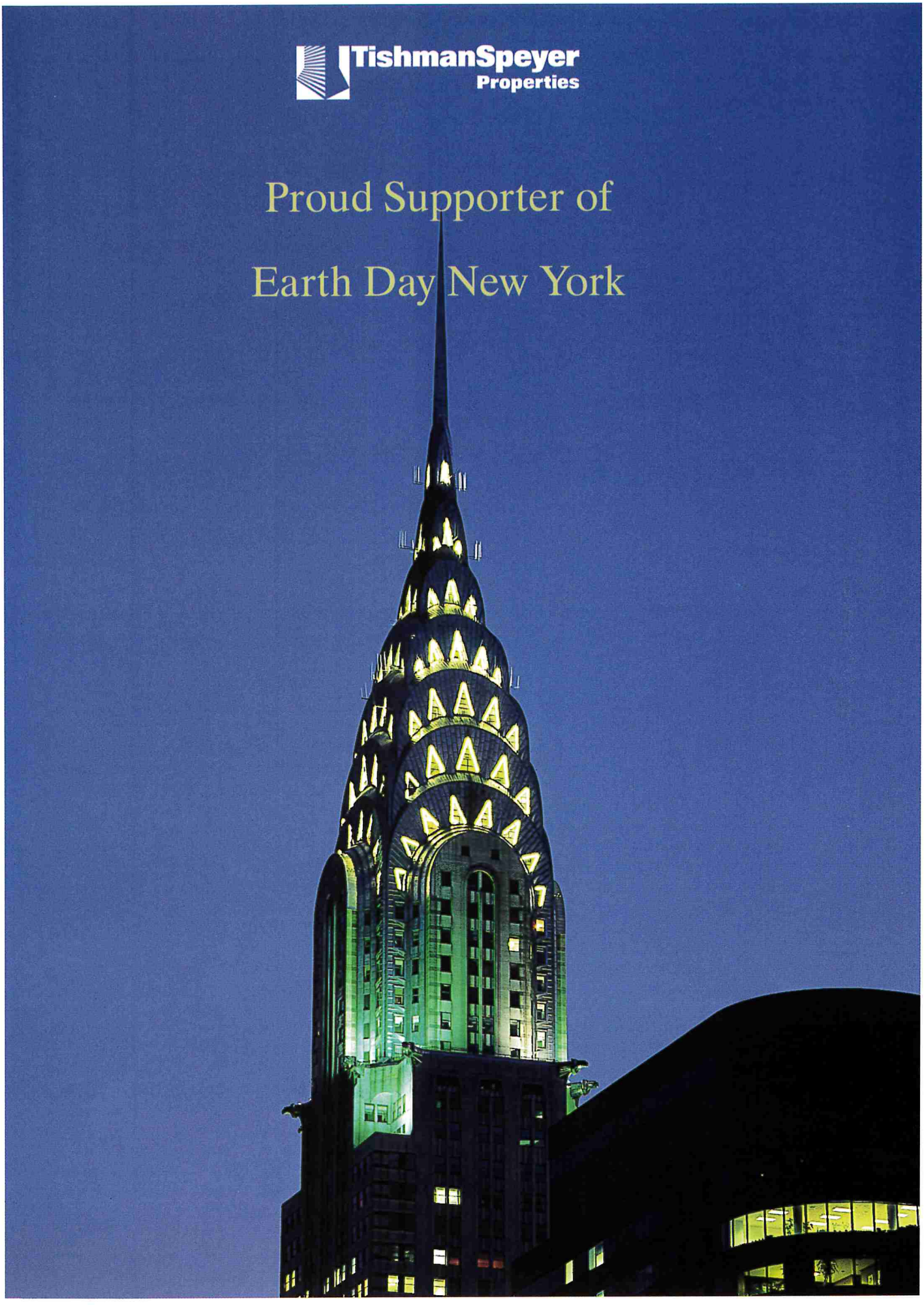

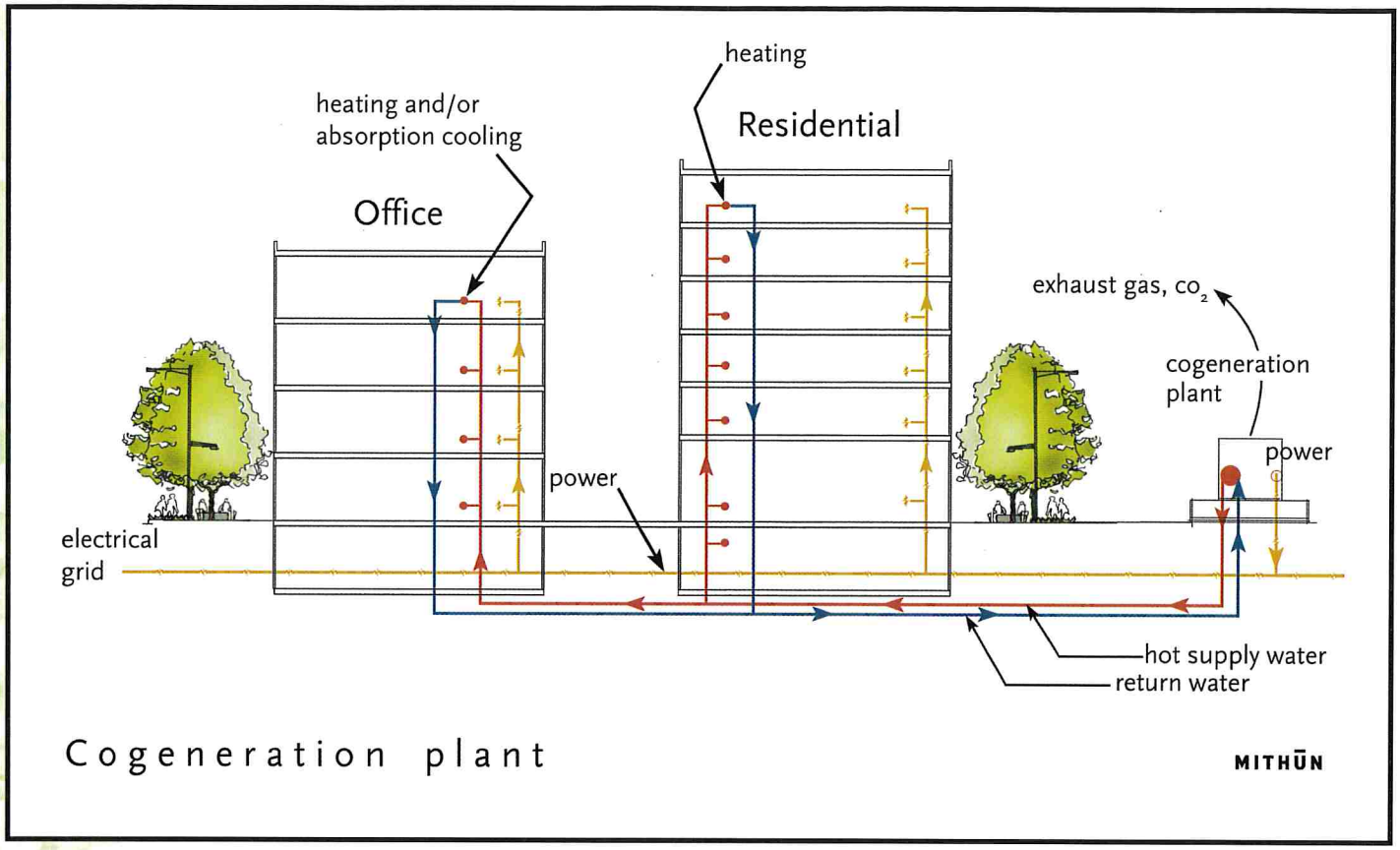

At a neighborhood scale, heating and cooling can be balanced between different building types, taking advantage of the efficiency of a whole system.

the right application, a developer can incorporate an on-site energy co-generation facility that can generate stable power while using the waste heat for building heating applications, improving overall resource consumption.

Consider both short and long-term benefits

Speculative developers struggle to reconcile immediate and long-term costs and benefits. On one hand, sustainable construction sometimes means higher up-front costs for materials and design features. On the other hand, many long-term benefits accrue, including lower costs of financing, operations and maintenance, improved employee productivity and retention as well as an improved environment and lower public infrastructure demands.

A building owner may not directly recoup money from a tenant's increase in employee productivity or improved retention that results from extensive daylighting or raised floor mechanical distribution system. However, this benefit frequently shows up as an advantage for the developer in leasing to corporate users or in establishing building value in the capital markets when the benefit of lower vacancy rates, lower insurance rates for healthy buildings, lower operating costs and securing longer leases can be realized.

Expanding the value equation

Green building is no longer just a trend. It's increasingly becoming an established market, having reached the "tipping point" of three-percent penetration that constitutes a confirmed cultural pattern. Buildings constructed to the US Green Building Council's LEED standards went from 8.4 million square feet nationwide in 2000 to an astounding 71 million just two years later. Market demand is here, and developers who provide buildings that meet credible sustainable criteria have an edge over their competition today – and will meet even more urgent market demand tomorrow.

So how can developers move ahead with these concepts in an already risky market? Here are a few economic strategies for adapting the financial equation, and therefore, managing project risk when choosing sustainable development.

Create economic value by helping reduce risk

Many common risks associated with construction in general, and sustainable construction in particular can be mitigated through wise practices. For example, adding flexibility to the project design allows a change of use, which reduces business risk. Using sustainable resources buffers against changes in technology or energy price levels, and hence further reduces an

owner's risk. Following LEED standards for indoor air quality or adopting low-impact construction practices may reduce environmental risk.

The reduced risk for projects adopting green guidelines should eventually increase building valuation and reduce the rate of return required by investors providing capital for these projects. And depending on the cost associated with adopting these strategies, this reduction in the cost of capital can improve operating and project value, as will be illustrated later.

Transfer costs below the budget line

As a project approaches completion, the team must make a series of choices to determine the final constructed project. Many compromises take place at this point. They can choose to upgrade to a pricey marble floor, for example. Or they might allocate the flooring upgrade funds to a more energy-efficient lighting system, still remaining within the original budget parameters.

Sustainable cost transfers within a fixed budget eliminate certain elements and transfer costs to other elements that have a higher environmental benefit. A common strategy is to shift money from mechanical systems budgets to building envelope budgets. Air conditioning can sometimes be minimized or even eliminated through good design and related budget line items transferred to operable windows for natural ventilation. Another possibility would be using multi-functioning natural drainage systems on site to reduce the amount of land dedicated to stormwater management.

Build value with a "green" brand

A strong "green" building brand can add considerable value to a project. With a viable brand of sustainability, the overall value impact of a bundle of features (or strategies) is frequently greater than the sum of the individual strategy impacts.

Strong brands require at least three things: (a) a promise of a benefits package that people value; (b) confidence that the brand owner can provide the value package; and (c) consistent delivery of the promised value package. A "green" value package can offer all three, with a combination of aesthetic benefits, environmental benefits, health benefits and the benefits associated with reliable, high-quality power. Additional impacts are the attraction and retention of employees and residents to a neighborhood for its specific innovative characteristics.

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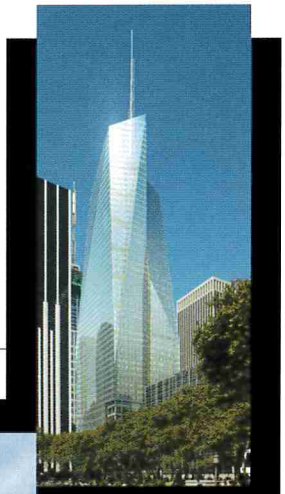

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Leverage flexibility to enhance viability

A commercial building in the United States typically lasts 40 years. One of the best ways to minimize the environmental impact of a commercial building is to ensure that it is fully and productively utilized over that time period (or even longer). This is not as easy as it sounds. Over four decades, the efficiency of most building systems will improve dramatically, prices or utilities will probably increase markedly, the facility's occupants will experience many different business cycles, and the needs of these occupants will evolve as technology and business practices advance. Key to a long life for a commercial property is the flexibility to adapt to changing conditions. This type of flexibility has two financial impacts. First, the building can be adapted to changing requirements, reducing the risk of investment. And second, flexibility increases the building's expected life, income and value. In short, adding flexibility enhances economic sustainability.

Economic sustainability supports and reinforces environmental sustainability. It does this by precluding the need to replace the building prematurely, reducing overall impact on the environment. Also, the flexibility features that add the most value are generally those with the greatest influence on reducing environmental impacts. Understanding why this is so will take a little more discussion concerning the value of flexibility.

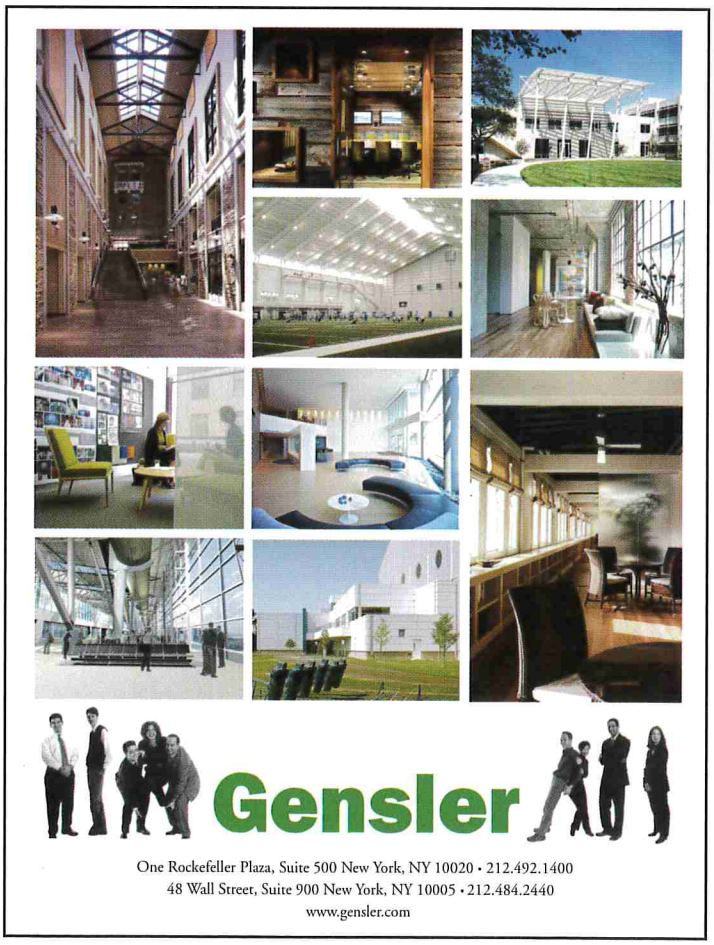
The value of flexibility is directly related to the amount of uncertainty surrounding factors that will require adaptation. For example, if the price of butter is increasing and it routinely fluctuates by 50 percent or more every month, then the flexibility to switch to margarine would be very valuable to a business that uses a large amount of butter. Alternatively, if the price of butter is relatively stable or declining, then the flexibility to switch to margarine would probably not be worth much.

For development projects, a major source of uncertainty comes from prices for electricity and water, commodities that are becoming increasingly scarce and have a number of related environmental impacts. As a result, we can predict to see increasingly high values for buildings with the flexibility to use renewable energy sources and/or encourage conservation.

Another facet of flexibility is a design that permits implementation of sustainable solutions at a later date. This could be done with the expectation that inflation, technological developments and/or a longer investment horizon would make sustainable strategies economically viable for a subsequent owner. Examples may include a rapid photovoltaic retrofit, providing for effluent wastewater treatment retrofits, graywater recycling providing for fuel cell technology and providing for the later installation of on-site energy co-generation.

Through multidisciplinary integration, expansion of the value equation and designing for flexibility, developers will find that sustainable buildings are a very achievable goal – improving economic return to owners, minimizing needs for new public resource infrastructure and supporting the health of our citizenry for decades to come.

Bert Gregory, *AIA, is President & CEO of Mithūn, a 145 person Seattle firm. Bert's progressive, design-oriented architectural background has led to award-winning projects throughout North America and Asia. He is a recognized expert in resource efficient design, speaking nationally on sustainable building & sustainable urbanism. Bert possesses a diverse project background, which includes architectural projects such as IslandWood, the Northwest's innovative outdoor learning center, to urban design plans such as "The Blue Ring," Seattle's ASLA National Honor Award winning City Center strategy, and Portland, Oregon's new zero carbon Lloyd Crossing Sustainable Urban Design Plan. He recently served as President for the Seattle Chapter American Institute of Architects. Bert's national impact in design leadership has been noted by the AIA, the IIDA, and CoreNet Global, which honored Mithun with the 2003 Sustainable Design Leadership Award. Mithūn has received three AIA COTE Top Ten United States Green Projects awards, all under Bert's design leadership.*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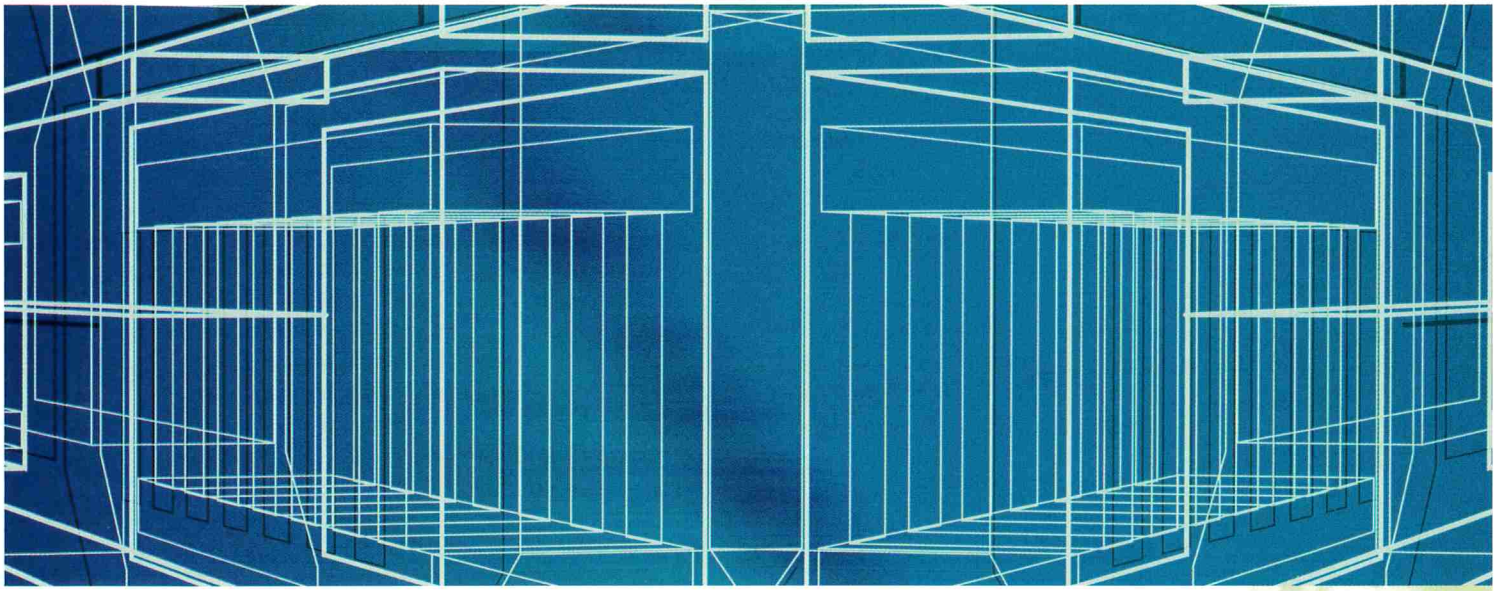

PUBLIC POLICY AND ACTION: MAINSTREAMING HIGH PERFORMANCE BUILDINGS

Timothy S. Carey
Hugh L. Carey Battery Park City Authority

It has long been the belief of the Pataki Administration that one of government's key functions is to impact the marketplace. In keeping with this ideal, the Battery Park City Authority (BPCA) embarked on an endeavor to make sustainable residential high-rise development a commonplace occurrence within the construction industry in New York State and beyond.

Anyone familiar with Battery Park City's history would not be surprised that the nation's first sustainable high-rise residential building is located there. In many ways, it's a logical next step in the evolution of this 92-acre "urban laboratory" located on Manhattan's lower West side across from the former World Trade Center site.

Battery Park City's beginnings date back to 1966, when Governor Nelson Rockefeller unveiled his plans for a "comprehensive community" to be built over the deteriorating piers of the Hudson River. The idea was to construct an urban neighborhood utilizing the very best in architectural and technological innovation that would set new standards for residential and commercial development.

In 1968, the New York State Legislature created the Battery Park City Authority to oversee the project. Under the plan, private developers would have the opportunity to lease individual plots of land from the Authority through a public process. The leases would run through the year 2069 (99 years from the start date). Battery Park City Authority would collect Payment in Lieu of Taxes (PILOT) as well as land rent. After payment of debt service, operating and administrative costs and PILOT, any surplus funds realized by the Authority from lease payments would be turned over to the City of New York for a use decided upon by the New York City Mayor, Comptroller and the members of the Battery Park City Authority Board.

Beginning in 1969, a series of unrealized Master Plans were proposed for the site, many of which embodied radically futuristic urban design concepts exemplified by projects like Brasilia and Habitat at Expo '67 in Montreal. Ultimately, a plan by Cooper-Eckstut envisioning a balance of commercial, residential, retail and park space was adopted in 1979.

In 1980, construction began on Gateway Plaza, the first residential development in Battery Park City, and not long after, the Authority adopted strict design guidelines encouraging developers to design buildings that embraced the most enduring features of New York City neighborhoods.

The following year, Olympia and York began the construction of the World Financial Center complex. It was under this lease agreement that the Battery Park City Authority realized its first surplus, starting Battery Park City on the road to becoming one of the most beautiful and successful planned urban communities in the world.

In the year 2000, BPCA Chairman James Gill and I

realized that we could change the way construction was done in Battery Park City. We had a master plan for site development that included commercial, residential and recreational space, and we had a set of design guidelines that prescribed what the building should look like. The only thing left was to create a set of guidelines for how the buildings would function and how they should be built.

Working with a team of experts and following the US Green Building Council's LEED® rating system – a voluntary program for measuring commercial building performance – the Battery Park City Authority developed our Residential Environmental Guidelines or "green" guidelines as they have now come to be known. The guidelines address the areas of:

- Air Quality
- Water Conservation
- Energy Conservation
- Recycling
- Commissioning

Once the guidelines were developed, we worked with city and state regulatory officials, as well as labor unions, to decide whether or not they could be implemented according to existing code. Though some were within code, many needed a waiver, which was applied for under a section of the New York City Charter allowing commissioners to make exceptions for new technologies.

With the residential guidelines in place, the Authority then went in search of a developer. We did it through our usual Request for Proposal process, whereby developers offer us a monetary bid for ground lease and a design concept for the building, but this time we requested that they also meet the criteria of our "green" guidelines. Though there were many members of the building industry who believed the RFP wouldn't receive any bids, we actually received nine.

Ultimately, the site was awarded to the Albanese Development Corporation whose President, Russell Albanese, worked with Rafael Pelli of Cesar Pelli & Associates to pull together a plan for the nation's first comprehensive sustainable residential building called The Solaire.

The Solaire is one of eight "green" residential high-rises to be developed in Battery Park City and was fully rented within six months at a four to five percent premium. Other developers who have been designated to develop according to our "green" guidelines include: The Related Companies, Millennium Partners and The Sheldrake Organization. It has been exciting to see them enthusiastically embrace the approach and then use it in their marketing efforts.

Our decision to embark on sustainable high-rise development may have seemed unconventional at the time, but after demonstrating that there was a market for healthier living, the idea has begun to take root. The construction of The Solaire has had an important impact on the marketplace in the amount, type and cost of sustainable products available to developers and has fostered a new way of thinking about product packaging to minimize construction waste. It has also helped spur the availability of healthier, more efficient apartments for the consumer.

In 2002, we developed commercial green guidelines for the last commercial site in Battery Park City. Goldman Sachs will develop Site 26 as its world headquarters.

Using public policy to impact the marketplace just makes sense. It's a powerful tool to introduce new technologies and standards that can have a positive impact on the citizens it serves.

Timothy S. Carey *is President and CEO of Hugh L. Carey Battery Park City Authority, a unique, 92-acre planned community located on Manhattan's lower west side. As President and CEO, Mr. Carey oversees the environmentally balanced development of this distinctive waterfront community that is home to the World Financial Center, 30 acres of parkland, and over 9000 permanent residences. He also had the unprecedented responsibility of directing the process to develop the first sustainable "green" residential high-rise building in the United States, The Solaire. Mr. Carey's keen interest in education led to his appointment to the Board of Directors of Westchester Community College where he currently serves as Chairman. Mr. Carey also serves as a member of the New York State Energy Research and Development Agency and the New York State Power Authority. Before coming to the Battery Park City Authority, Mr. Carey served as Chairman and Executive Director of the New York State Consumer Protection Board. From 1995 to 1996, Mr. Carey served as a member of Governor George E. Pataki's Cabinet as Director of Intergovernmental and Legislative Affairs.*

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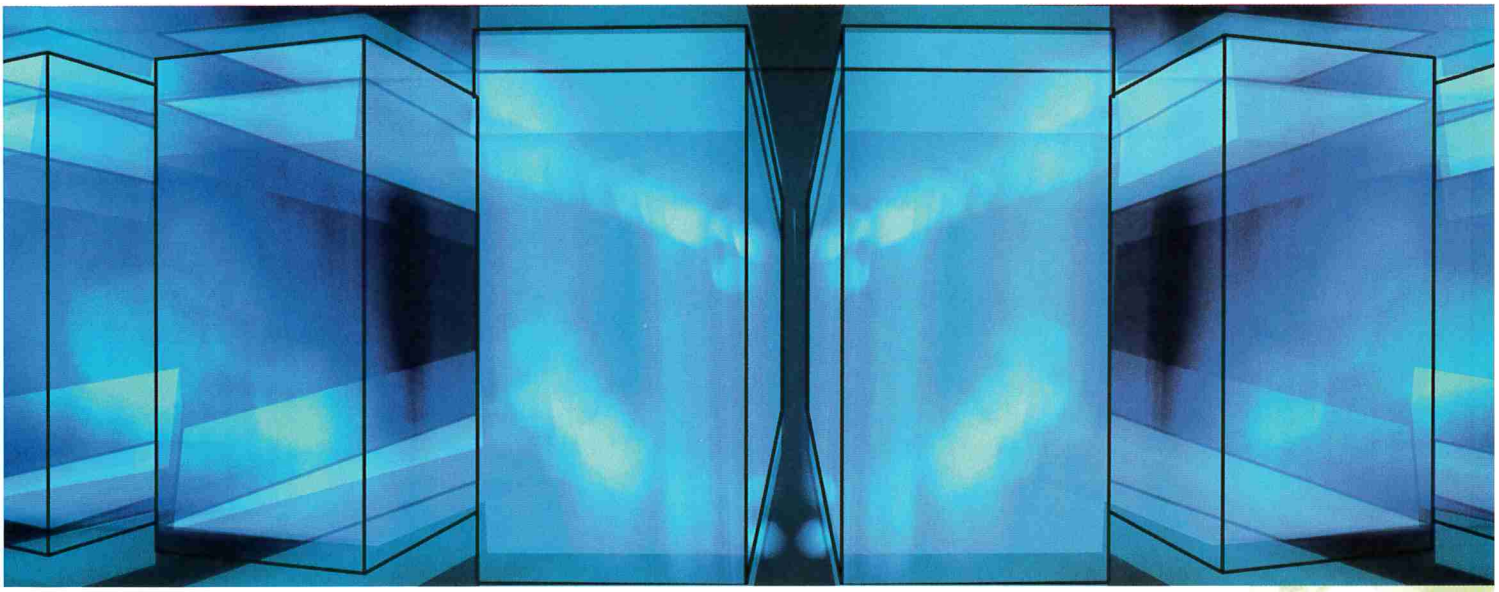

LOOKING TO THE FUTURE: BEYOND HIGH PERFORMANCE DESIGN

Bob Berkebile
BNIM Architects

"The best way to predict the future is to design it."
Buckminster Fuller

Fifty years ago, Fuller suggested we design a future that ensures the health and well being of "spaceship earth's occupants." Today, after centuries of business as usual, the design and construction industry shows clear signs of transformation. The premium for green is falling precipitously. Integrated design projects are offering net savings. The costs for sustainable projects are coming down while performance, flexibility, durability and beauty are going up. Decision makers at every level are figuring it out: Sustainable design is intelligent design. It's not just another option; it is becoming the only course of action for smart decision makers.

Most of the measurable benefits at this point are financial. We have just begun to explore the full implications of *good* design. We have yet to embrace a more complete definition of economics – the management of human health, community and environment. Most of our current designs, including those that are being certified by the US Green Building Council's LEED® rating system, are only reducing their environmental impact as opposed to restoring environmental vitality – doing less bad, rather than doing good. Very few are reaching for designs that simultaneously increase the social, economic and environmental vitality of our communities.

The World is Not as Patient as it Used to Be
Consider the technologies Thomas Jefferson utilized for communication and construction. To communicate with his associates in Europe as he was designing Monticello and the University of Virginia, Jefferson had his hand-drawn sketches and notes delivered to the coast by horse and on to Europe by sailboat. He had to wait months to receive a response. Today, wireless technology has reduced this exchange to minutes. But lightspeed change is hard to find in the world of design and construction.

In fact, it is difficult to identify significant improvements between Monticello and Washington DC's newest structures. Jefferson's buildings were more resource efficient, healthier, more durable and less polluting than most new buildings!

Our industry is beginning to embrace change at an unprecedented rate. Many of the examples reported in this publication would bring smiles to the faces of Jefferson and Fuller. These successes are increasingly convincing building owners, occupants and diverse members of the design, manufacturing and construction industries that "green" is good.

Designing the Future
Every day now, we see exciting new holistic/integrated design concepts and breakthroughs in science and technology. Collaborative teams of designers and stakeholders are utilizing the rapidly expanding body of knowledge at breathtaking speed. New communication systems are facilitating the rate of exchange. Designers, scientists, environmentalists, manufacturers

and government are collaborating on promising areas of discovery, including: biophilia, biomimicry, architecture and neuroscience, sophisticated/integrated decision making, measurement and feedback systems, pedagogical designs, and designs to increase social capital. Information emerging from these initiatives helps us better understand present conditions and inform our designs.

We Will Know the Future Has Arrived When...

- Our buildings and communities are living systems. Beautiful and healing. Dynamic. Responsive to the forces of nature.
- Our community designs celebrate diversity and contribute to social harmony.
- Our building designs increase human capacity and conserve natural capital.
- Our buildings operate like living organisms specifically adapted to place. They draw their requirements for energy and water from the sun, earth, wind and rain without further diminishing our natural resources.
- Architecture draws inspiration, not from western scientific thought and the machines of the 20th century, but from the flowers and trees that provide us life and lift our spirits.
- LEED® is obsolete.

Smart Decisions Anticipate the Future

Leading developers and real estate managers are tracking these trends and refining their strategies with remarkable results. State-of-the-shelf integrated design and management concepts are providing more daylight, comfort and flexibility with attendant increases in visual acuity, cognitive capacity, well being and produc-

History and Major Influences of Green Design

In the mid 1800s, the discovery of oil and the industrial revolution, built on the concept of unlimited natural resources and limited human resources, changed our approach to the built environment. This event, combined with glazing systems and Dr. Carrier's cooling systems, fundamentally changed our relationship with nature.

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In the mid 1900s, following WWII, the Federal Housing and Transportation Acts, combined with mass-produced housing, accelerated the consumption of land, energy and raw materials and reduced the durability of American homes.

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In the 1960s, Rachael Carson's *Silent Spring* sounded a "wake up call" concerning the unintended consequences of our decisions. This occured just prior to the creation of the first PV cells and fuel cells, which in turn preceded the first blackout for 30 million US and Canadian residents.

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In 1970, the Environmental Protection Agency was created and the first Earth Day was held.

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In the 1970s, the Arab oil embargo doubled the cost of crude oil and created a US energy crisis.

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The 1980s brought some of the first contemporary green buildings, including the Bateson building in Sacramento, California, the NMB Bank in Amsterdam and the Rocky Mountain Institute in Old Snowmass, Colorado.

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Not long after, scientists discovered that chemicals used to cool our buildings had punched a hole in the protective ozone layer, the Chernobyl nuclear accident occurred and the Exxon Valdez ran aground and spilled 11 million gallons of oil.

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On the positive side, the Brundtland Commission coined the term "sustainable development," the Montreal Protocol was adopted to phase out CFCs, and the American Institute of Architects created the Committee on the Environment to help create and promote more sustainable designs for our buildings and communities.

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In 1992, Agenda 21 was created at the first Earth Summit in Rio de Janeiro defining new strategies for creating sustainable communities, and Paul Hawken's *Ecology of Commerce* was published.

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In the mid 1990s, the US Green Building Council was created. A series of national demonstration projects beginning with the Greening of the White House and the Pentagon resulted in an appreciation for collaboration, an increased diversity of consultant teams and improved tools, standards and measurements. Four Times Square, the first environmentally responsible skyscraper in the US, was designed and built in New York City.

ISO 14001 was adopted as an international standard for corporate environmental systems. Janine Benyus's *Biomimicry: Innovation Inspired By Nature* and RMI's *Green Development: Integrating Ecology and Real Estate* were published, and the CK Choi research facility was completed in Vancouver, setting a new benchmark for building performance in North America.

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In 1998, the Kyoto Protocol was signed by most of the world.

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In 1999, *Natural Capitalism: Creating the Next Industrial Revolution* by Paul Hawken and Amory and Hunter Lovins was published, and the USGBC introduced the pilot version of Leadership in Energy and Environmental Design.

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In 2000, the USGBC LEED rating system 1.0 certified 12 new buildings, including the "Platinum" Chesapeake Bay Foundation (the highest in the system) and the Lewis Center for Environmental Studies in Oberlin, Ohio.

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In 2002, the David and Lucile Packard Foundation Report documented that designing and building at a level of performance above LEED Platinum was the most intelligent financial decision for them or anyone intending to own and operate the facility for more than 20 years, even without considering the benefits to health and productivity.

tivity. These benefits are often being accomplished with little or no increase in capital cost and significant reductions in operating cost, as reported elsewhere in this publication.

Many of these trend setters are tracking the environmental impacts of their projects, including consumption of energy, water and materials, and reductions in pollution, and they are reporting the results to gain market advantage. Increasing numbers of developers are embracing designs that improve the sense of community, vitality and security in both the public and private realms.

For a growing family of industry leaders, these emerging strategies are increasing market share and return on investment. For them, Bucky Fuller was correct. Why wait for the future, if we can design it right now?

Bob Berkebile, *FAIA, is a leading authority in the field of sustainable design and is the founding chairman of the American Institute of Architects' National Committee on the Environment. He is a Principal of BNIM Architects, and Elements Consulting, and brings 40 years of diverse experience to the profession. Bob currently serves on the boards of The Nature Conservancy,* Environmental Building News, *The Center for Global Community, Athena and New Earth Organization. He was a member of the US Green Building Council board and currently serves on USGBC's Technical and Scientific Advisory Committee. He has conducted numerous sustainable design charrettes and workshops for the White House, DOD, DOE, NPS, FEMA and the Canadian Provincial Architects. He has lectured extensively at universities, and at international conferences including The Earth Summit in Rio and UN or NSF conferences in Scotland, Sweden and Antarctica. Some of his representative projects include the Noisette Development (a 3,000 acre redevelopment) in North Charleston, South Carolina, several benchmark projects for healthy, efficient facilities at the University of Texas Health Sciences Center in Houston, a learning center promoting sustainability and conservation ethics at Shelburne Farms, Vermont, the Missouri Department of Natural Resources headquarters in Jefferson City, and the Missouri Department of Conservation's Urban Conservation Campus in Kansas City.*

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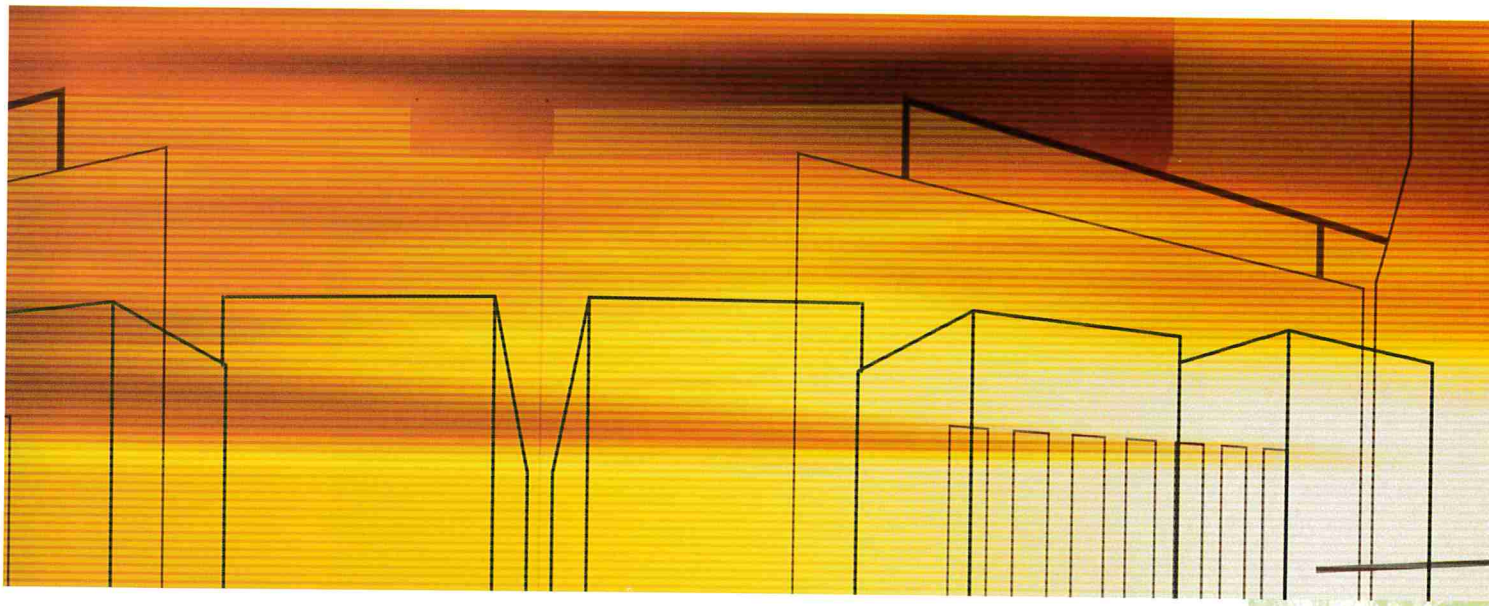


THE NEW YORK TIMES: A MELDING OF HIGH DESIGN AND PERFORMANCE

Bruce Fowle, FAIA
Fox & Fowle Architects

The New York Times Building combines design and environmental excellence with a vital corporate mission and commercial opportunity. The New York Times, that will occupy the lower half of the building, wanted a memorable, yet timeless new home that would very distinctly express its mission of transparency and service to the public for the next hundred years. Forest City Ratner, the developer of the project, is planning to lease the other half of the project's 1.6 million square feet and needed a marketable speculative development that would be viable in the city's currently challenging economic environment.

The approach to meeting this programmatic challenge began with a multi-faceted design team. Renzo Piano Building Workshop (RPBW), the winner of the design competition for the project, brought a sensitive and exemplary concept, a spirit of European innovation and an artisan-based approach to the project. RPBW looked to Fox & Fowle Architects (FFA) for large-scale urban experience, knowledge of the New York City construction industry and leadership in sustainable design. The team was bonded through a synergy of working styles and a steadfast dedication to design excellence.

In the winning competition entry, RPBW imagined a slender, diaphanous tower with several innovations untested in the New York market, such as the intricate curtainwall and exterior sunshading system. The main challenge was developing a feasible, economically viable building, while preserving the nobility of the design concept and carrying it through the details. Maintaining environmental responsibility within the many urban constraints and complex programming presented another challenge. In translating the design concept to the scale of a commercial 52-story building, the team was able to unitize the building materials, control the cost, and provide constructability within the rapid development schedules of New York City. The team's unwavering dedication to elegant, innovative and mission-oriented design resulted in a building that balances design, programmatic and environmental excellence.

In contrast to the solid aesthetic of many urban office buildings, the New York Times Building is sheathed entirely in low-iron clear glass. This transparency, revealing the activity within, embodies the paper's mission of transmitting an unclouded, lucid report of the news to its public.

The most innovative feature of the curtainwall design is an exterior veil of ceramic tubing that functions as both an aesthetic device and provides critical sunshading. Aesthetically, the tubing serves as a canvas for the environmental conditions, changing color with the sun and weather. This extra exterior layer allows for the use of floor-to-ceiling glass, by deflecting the sun and mitigating the loss of energy efficiency expected in a clear glass building. The cruciform shape of the tower floorplate, with a maximum distance of 42 feet from perimeter to core, allows daylight to penetrate deeply into every floor. The tubular layer is critical to limiting the building's energy consumption, reducing solar heat gain by 30% and energy costs by approximately 13%. In addition, in the Times space there will be an automated roll-down window shade system to supplement the

tubes and control early morning and late afternoon direct sunlight and glare. These controls, in tandem with daylight dimming systems, have been studied extensively in a full-sized mockup of one-fifth of a typical tower floor. The New York Times, with a generous investment by the New York State Environmental Research and Development Agency (NYSERDA), contacted the Lawrence Berkeley Laboratory to work with them and the interior architectural design team (which includes Gensler, Susan Brady Lighting Design, Flack+Kurtz and Turner) to develop the first large scale proposal of automated roll-down window shades and daylight dimming in a commercial office building. The refinement of the system that has evolved through this process will have a significant effect on the cost and efficiency of the installation, and should benefit the industry at large going forward.

The team tested many different types of materials for the tubing, including traditional terra cotta, clay, aluminum and various ceramics from around the world. Aluminum silicate, an extremely dense and high-quality ceramic used for special manufacturing purposes, was chosen for its long-term durability and cost-effectiveness. The silicate tubes will be glazed with a finish similar to terra cotta to reflect light, self-clean and ensure its resistance to weather. The team also conducted testing to determine the distance necessary between the glass curtain wall and the tubing to allow for efficient window washing and façade maintenance. It is anticipated that this tubing will have the added benefit of reducing migrating bird impact – a major concern on the East Coast fly-way.

The New York Times required extremely large floorplates for their newsrooms, which are provided in the four-story "podium" at the base. At the center of the podium's 60,000 square foot floors, there is a 4,000 square foot exterior courtyard set on earth. Designed by landscape architect HM White Site Architects and Cornelia Oberlander, its garden emulates a moss glen indigenous to New York State featuring a bosque of native birch trees. Besides enhancing the working environment of the newsroom and the public spaces at grade, the garden reduces stormwater runoff and heat island effect while absorbing carbon. A high-efficiency moisture-sensing drip irrigation system provides water only when necessary. Visible at street level from three sides of the building, through the multiple layers of the lobby's transparent glass, the garden contributes a calming community amenity to a neighborhood with little public space. The selection and positioning of the plant materials resulted from an extensive daylight and shadow computer modeling study.

Natural light is brought into the eastern end of the podium through a large skylight above a two-story atrium that serves as the nucleus of the newsroom activity. The skylight is shielded by an external automated louver system that adjusts to the solar angle and intensity, thus minimizing solar radiation and glare while maximizing light and reducing the cooling loads of the space below.

In the notched corners of the building's tower, the structure is exposed to the exterior, contributing to the aesthetic and furthering the display of transparency. Working with Thorton-Tomasetti, the structural engineers for the project, the team was challenged to find a method to fireproof the steel and make its exterior appropriate without expensive cladding. Through collaboration with steel fabricators and many other related trades, the problem was solved by using exposed steel members with intumescent coating and careful detailing of the components.

The New York Times Building incorporates a cogeneration plant which will power its 24-7 operation and provide virtually all of the Times' hot water needs for the building. Located in a mechanical room at the far end of the podium's top floor, the cogeneration plant consists of two natural gas-fired reciprocating engine generators

with a total capacity of 1.5 megawatts of electrical power. The cogeneration plant, designed by Flack+Kurtz, the mechanical engineers for the project, recovers the heat produced by combustion and converts it into useable energy in the form of hot water.

The recovered hot water serves the Times' portion of the building's heating loop to provide warmth during the winter. In summer, it will serve the hot water absorption refrigeration machine to provide cooling during the warm seasons. The heat recovered from the generators is 8.3 million btus per hour, sufficient to heat 50% of the building on a typical winter day. Extensive measures to isolate the equipment were implemented to address the normal acoustic and vibration issues with cogeneration. Putting the plant in the basement could have alleviated some of these measures, but would have required the use of more ductwork and enlargement of the building volume. Although the team ultimately negotiated a satisfactory agreement with Con Ed for the power required from the grid, projects hoping to replicate this dual approach must start as early as possible to avoid disruption in the design schedule.

As part of the team's effort to enhance the indoor environmental quality and energy efficiency, the project will incorporate the first major underfloor air distribution system in New York City. By investigating installations of underfloor air around the country and in Europe, The Times became convinced that the system would benefit the company and its employees, through enhanced air quality, comfort, individual control and increased energy conservation. A great deal of thought and study went into the design of this system. A series of off-site think-sessions with the entire team, including extensive laboratory tests, were required. The pre-purchase of the underfloor system and the use of a comprehensive commissioning process to ensure its proper functioning were essential components of the decision.

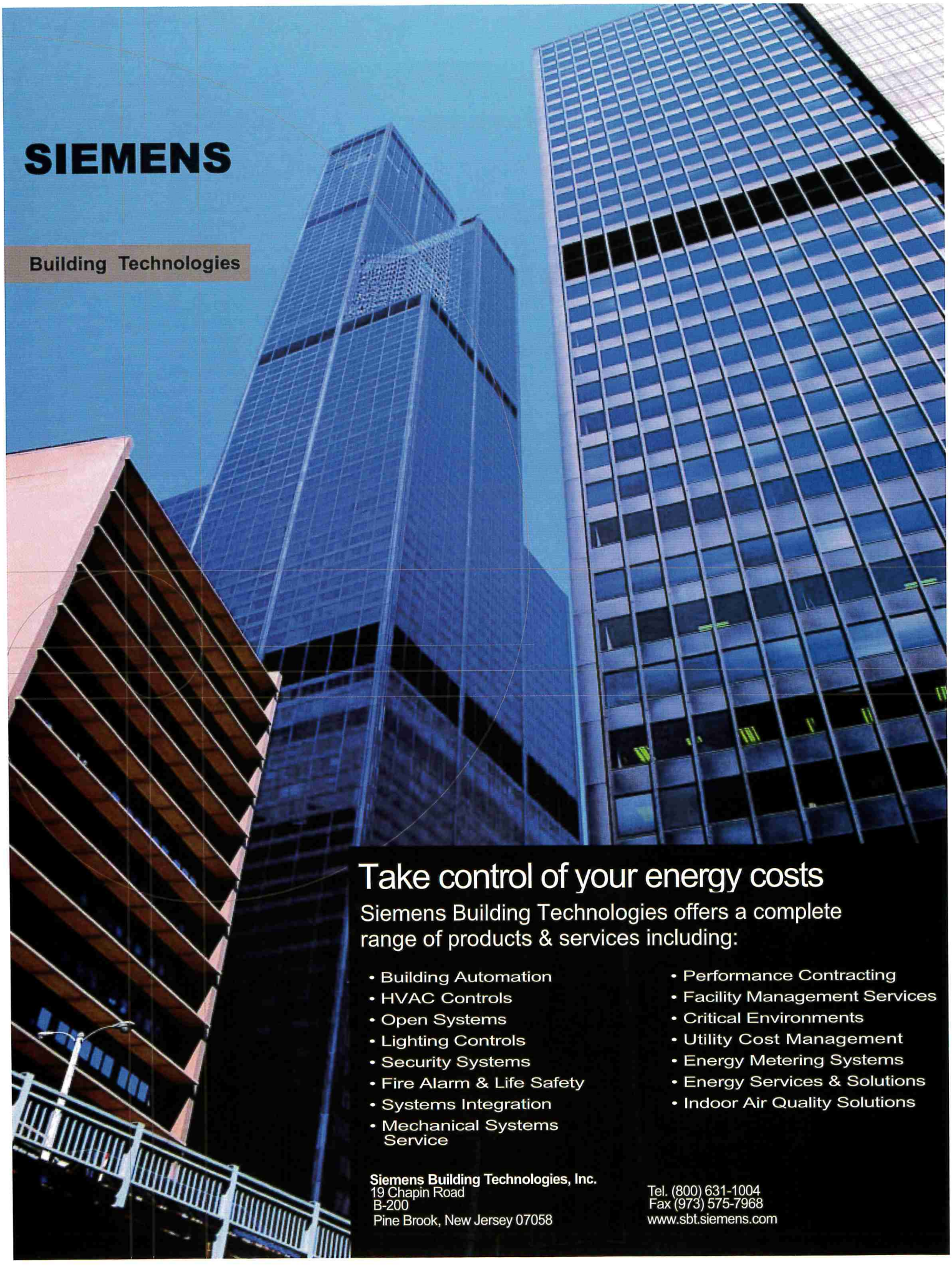
The design of the interior environment, developed under the leadership of Gensler, the project's interior architects, in collaboration with RPBW and FFA, continues the physical embodiment of the New York Times' mission. Accessible interconnecting stairs between office floors promote interaction among employees, ease internal movement, reduce elevator load, and are a potent symbol of the Times' organizational commitment to breakdown barriers between departments. Positioned at the exterior walls, movement along these stairways will be visible from the exterior and adds to the feeling of openness as one moves through the space and views the building from street level. The assembly of the stairs was studied as part of the full-scale mockup; since they are an integral component of the building, the lessons learned from the pre-construction mockup continue to unfold exponentially, justifying its cost many times over.

Just as the mock-up tested the curtainwall and interior assemblies, an installation at the newspapers' current location has provided valuable information on the benefits and liabilities of various waterless urinals. The Times installed two types of waterless urinals from two different manufacturers and conducted a health study and user survey over nine months. Providing this information to the City allowed the team to get unprecedented approvals from both the Department of Buildings and the Department of Health for incorporation throughout the new building. However, as a result of employee feedback, the Times has decided not to use these urinals in the building.

An application for LEED certification of the project is pending. The level of commitment has not been finally determined as of this writing.

When complete in early 2007, the New York Times Building will bring a fresh new character to the New York City skyline, a vibrant piece of crystalline architecture that treads lightly on the natural environment and provides inspiration for many years to come.

Bruce S. Fowle *is a founding Principal of Fox & Fowle Architects and has been the firm's visionary leader since its inception twenty-six years ago. The architecture, planning, and interior design firm, based in New York City and employing one hundred people, has received numerous prestigious awards. As a long time proponent of environmental conservation, Mr. Fowle helped guide the firm to a leadership position in sustainable design. Among its achievements are the design of the first green skyscraper in the country, the first green guidelines for residential high-rises in New York, and green guidelines for a number of institutions and regional transportation systems.*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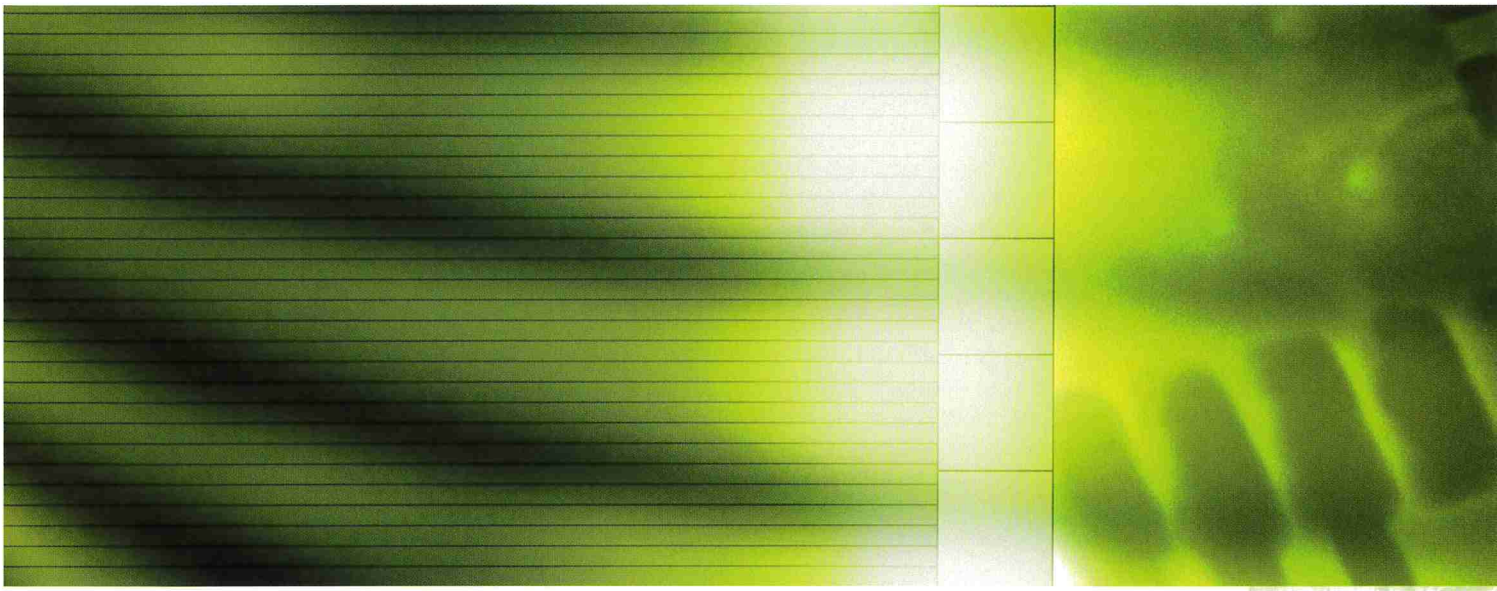


GETTING IT RIGHT: PROVIDING ENERGY EFFICIENCY AND COMFORT IN AN ALL-GLASS BUILDING

Stephen Selkowitz,
Lawrence Berkeley National Laboratory

Transparent Buildings: Background and Context

The growing interest in sustainable design in the U.S. has fostered a renewed interest in the role of glazing in building facades. Highly glazed building façades have always had a dramatic architectural and aesthetic impact, embodied most notably over the last 30 years in the iconic smooth reflective glazed façades of many low-rise and high-rise buildings. With monolithic glass and no external shading, the tinted and reflective glass typically selected has a very low solar heat gain coefficient and low daylight transmittance.

Even with large HVAC systems, thermal comfort is often a problem in spaces adjacent to such glazings. These façades allow views into the building interiors only at night; during the day they provide virtually no insight into the inner workings of the buildings, instead reflecting images of the surroundings. On cloudy days the occupants' views can be unsatisfactory and the spaces gloomy. They rely almost entirely on electric lighting to brighten the interior.

The traditional reflective glass commercial building is being challenged by a growing interest in the use of highly-glazed, transmissive façades. These façades have relatively clear, high transmittance glazing systems, and are typically outfitted with some form of sun control. With origins in Europe, the trend is expanding to other regions, including the United States. The stated rationale varies but often includes occupant benefits as well as sustainable design attributes associated with daylighting and energy savings.

A number of technological advances have facilitated these new architectural approaches. Low-e glass and related thermal improvements have made glazed façades more efficient in cold climates. Spectrally selective glazings have made it possible to maintain high daylight transmittance while reducing unwanted solar heat gain and cooling loads. Both approaches contribute to improving thermal comfort. Innovations in sealants and structural use of glass have made a wider range of architectural solutions feasible and cost effective. There has been an increased use of daylighting both as an energy saving strategy and to provide other occupant amenities and benefits.

Despite this growing interest, "getting it right" remains a challenge. Elegant images in architectural magazines don't automatically translate into sustainable designs with proven comfort and energy performance. Controlling thermal heat loss and gain can be largely addressed with highly insulating glazing technologies on the market today. However, controlling solar gain and managing daylight, view and glare is at a much earlier stage in terms of cost-effective, available solutions.

In most cases, a static control solution, e.g., fixed shading, will not suffice. Some degree of active, rapid response to changing outdoor conditions and to changing interior task requirements is needed. This can be provided with

technology within the glass or glazing assembly or can be added to the façade either on the interior or exterior of the glazing. In all cases, sensors, actuators, and control logic are needed for proper functionality.

Traditional manually-operated shading systems such as blinds or shades can be motorized and then controlled by occupant action or by sensors and building controls. Emerging "smart glass" technology can dynamically change glass optical properties and can be activated either manually or by automated control systems. In each case, electric lighting should be adjusted to meet occupant needs while maximizing energy efficiency and minimizing electric demand. As with the fenestration controls, lighting control requires sensors (photocells or the human eye), actuation (switching or dimming) and a control logic (software or occupant preference) that determines what action should be taken under each set of conditions.

Some combination of these elements comprises the typical equipment and systems found in most commercial buildings today. The new challenge is to provide a fully functional and integrated façade and lighting system that operates effectively under all environmental conditions and meets subjective occupant desires and objective performance requirements. Finally, these rigorous performance goals must be achieved with cost effective, long lasting solutions that require minimal maintenance.

The building systems that would achieve these performance results do not exist today, at least not as readily specifiable and cost-effective options. While daylighting strategies can be successfully implemented in buildings with skylights and with some success in buildings with modest fenestration, highly-transparent buildings present a unique challenge. They provide an opportunity to advance the market for emerging, smart, dynamic shading and windows and for dimmable daylighting control technologies.

Without such systems, the architectural design intent is at risk for glare and overheating, and is subject to the ad hoc manual control of interior shades and light switches, with results that are usually less than satisfying. The integration of these two technologies will increase the cost-effectiveness of both. This may renew interest in designing floor plates and interiors to optimize daylight utilization throughout a greater percentage of the building's floor area.

It will take time and effort to change the marketplace but it is possible to accelerate the process by which technical solutions are improved and advanced. The interests of innovative owners and motivated manufacturers are converging.

Strange Bedfellows:
Building Owners and Researchers

The New York Times headquarters building, described in some detail by Bruce Fowle, utilizes a state-of-the-art high transmittance, double glazed, low-e, spectrally selective glazing assembly with an innovative fixed external shading system comprised of ceramic rods. However, due to the floor to ceiling glass, and the use of a rod-free vision strip, there will still be unavoidable periods of glare.

The Time's design team had the foresight to begin addressing these critical lighting quality and façade issues early while there was sufficient time to explore potential design options and implement them in the final building. One major challenge was finding solutions that addressed the thermal and luminous issues as an integrated, cost-effective and reliable package. Through the internet, the owner found daylighting experts at the Lawrence Berkeley National Laboratory (LBNL) who had worked with a variety of integrated daylighting and shading systems over the last ten years.

LBNL provided the building design team with two

Emerging Technology: *Research continues on coated glass whose properties can be electrically switched from highly transparent (65%) to very low transmission (4%) in a matter of minutes. A test facility at LBNL is used to quantify energy performance and to better understand occupant response to the control strategies and the comfort levels in the space.*

Photos: LBNL

Prototype electrochromic "smart glass" in a test facility at LBNL. Three sequential views of one test room in the LBNL façade test facility, showing the darkening sequence. Left: high transmission under overcast conditions; Center: sun emerges from clouds; Right: glazing switched to low transmission state to control glare and reduce cooling loads. The visible transmittance of these prototypes can be switched from 65% to 4% in several minutes.

new directions. Dimming ballasts had been dismissed as viable options based on manufacturer quotes of $60-120/ballast. LBNL staff had been exploring market trends and costs and had concluded that it should be feasible to profitably manufacture and sell dimming ballasts at much lower prices (e.g., $20-30/ballast). Direct contacts with key manufacturers confirmed these possibilities. The LBNL team also proposed using dimming ballasts throughout the building, simplifying replacement logistics and allowing tuning of light levels to variable task and personal requirements and providing the owner with peak electric demand control at all building locations. It was still unclear how all the shading and lighting hardware would be integrated, controlled, commissioned and operated as well as how that operation would influence light and occupant response in the space.

To address issues of glare, lighting quality and hardware integration, LBNL recommended that the Times alter their plans for a conventional furniture mockup (typically built full-scale indoors in a warehouse) and build an outdoor mockup instead. This would allow them to address some of the commissioning and integration issues, to see the impact of automated shade and dimmable fluorescent lighting management on lighting quality under real sun and sky conditions, and to assess the benefits of these technologies to harvest daylight. Allowing manufacturers to test their products in a mockup prior to bidding the job reduced uncertainty and provided another key strategy to ultimately lower costs.

In addition, The Times wanted feedback from future occupants in advance of construction to provide input on some critical interior design issues. After weighing potential costs and benefits, The Times decided to construct a 401 m^2 (4318 ft^2) mockup of approximately one quarter of a typical floor. Located in a parking lot at their Queens printing plant the mockup was oriented precisely as it would be at the final location in Times Square. Construction was completed in December 2003 and testing began immediately at the winter solstice, continuing until the summer solstice in June 2004.

Performance Assessment: New York Times Daylighting Mockup

It is highly unusual for an owner to build a mockup at the scale and complexity of this one. The Times paid the direct costs but the measurement and evaluation work by LBNL was supported by NYSERDA with co-support from DOE and California Energy Commission. The results are directly assisting The Times in critical investment decisions, but will also be shared industry-wide to benefit others.

When building owners research technology options, the usual questions surface: how will it work, are the vendor claims valid, what risks are incurred, and will performance benefits be sustained? Most designers and owners can't answer these questions and thus slow the pace of innovation. The New York Times mockup test program accomplished several objectives: 1) to enable vendors to prove their claims and fine tune their systems to meet the building owner's evolving requirements, and 2) understand the benefits and limitations of each manufacturer's approach to shade management and daylighting controls.

The fully furnished mockup was divided into two test areas. Two roller shade companies and two manufacturers of dimmable lighting systems installed commercially-available systems with different types of sensors and control strategies. The objective was not to do a side-by-side comparison of "competing" systems but to understand how vendor decisions regarding control infrastructure and design might impact actual field operation. The end goal was not product selection but rather the development of a detailed performance specification that would be open for bid by any vendor.

Monitored data was collected by LBNL from December 21 to June 21, capturing the full range of

Photos: LBNL

Photograph of mockup (left) and RADIANCE nighttime rendering of the same space (right)

solar conditions. During this time, the manufacturers were permitted to tune their systems to obtain optimal performance and improve their designs. The building owner was able to adjust some control settings to obtain a system that better met their needs. Manufacturers were able to alter their systems to better meet the owner's specifications. A subjective "occupant satisfaction" study was conducted to assess the lighting environment and acceptance of the automated technologies, and to explore how occupants might override the automated control strategies. Detailed luminance maps of work stations with computer monitors were taken at various locations within the mockup at different days and times to better understand the visual environment.

RADIANCE simulations (a ray-tracing computer tool for lighting and daylighting design) allowed the building owner to explore and visualize the impact of design options on glare, visual display terminal (VDT) visibility, illuminance and luminance distribution. The optical properties of the shades, all interior furnishings, curtainwall finishes including the ceramic rods, and the VDT were measured as inputs to the modeling work.

Initial project results have met or exceeded the team's expectations. First, the full size mockup provided hands-on, iterative testing and refinement of complex sensor/control/software systems allowing the owner to assess not only engineering data (e.g., kWhs saved) but also lighting quality issues.

The mockup showed that useful daylighting savings can be achieved throughout all the typical floor space, far deeper than originally planned. The notched corners provide large energy savings as daylight reaches the adjacent workspace from two directions.

Selecting the shade materials and control algorithms was one of the more challenging tasks. Low-transmission shades deployed frequently will control glare but limit daylight admittance. The shade fabrics used in the mockup control sky glare and enhance computer screen visibility under most typical conditions, while still providing energy savings. Additional test and simulation studies are underway with alternative shade materials to explore their performance in different parts of the building throughout the year.

A series of performance specifications for the key hardware purchases have been circulated to potential vendors and the ballast, shading and controls industry are now responding to them. Successful hardware bidders will be invited to install their systems in the mockup prior to bidding for installation and commissioning so that uncertainty and risk can be reduced, leading to more realistic and lower cost bids.

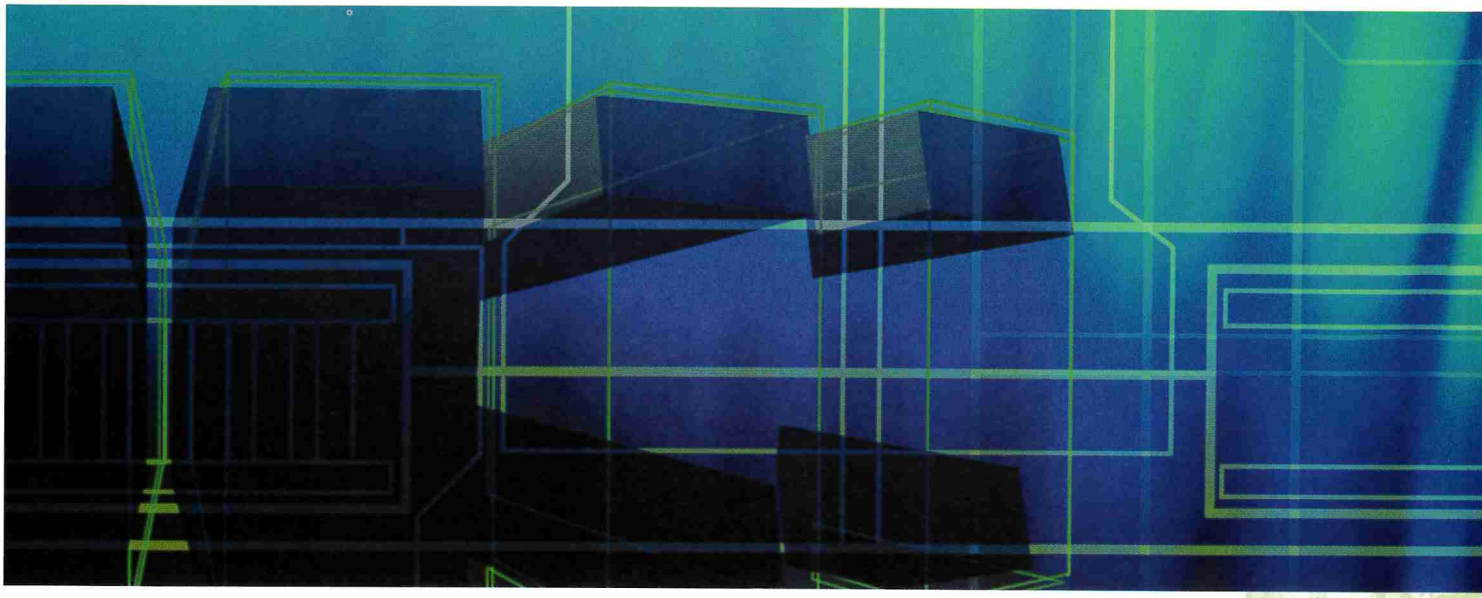
In addition to its value in resolving the façade and daylighting issues, the mockup also allowed The Times to better understand and refine critical construction details before the tower was built, reducing errors and cost. Problems caught at this stage can be solved far more effectively than when full scale construction is underway.

All participants are very pleased with results to date. The New York Times will get a building that will better meet its staff's needs, with fewer performance problems and at lower cost. The LBNL team and the public agencies that supported the research study have benefited because the R&D results are already influencing manufacturer's business practices and awakening other owners and design teams to the potential benefits of these design approaches. The cumulative market pressure from additional projects like this one will ultimately cause accelerated change in a marketplace that has been notoriously slow to adapt to emerging environmental needs.

Acknowledgements: The project was initiated at the New York Times by David Thurm, VP, Real Estate, and Glenn Hughes, Director of Construction, with assistance from a large team of designers and consultants. The LBNL research team is led by Eleanor Lee, with financial support from New York State Energy Research and Development Authority, and with co-support from the California Energy Commission and the U.S. Department of Energy.

For more info: see pages 126-129

Stephen Selkowitz *is Department Head of the Building Technologies Department, Lawrence Berkeley National Laboratory, LBNL, where he manages 80 technical staff in a buildings R&D program encompassing Windows and Daylighting, Lighting Systems Research, Computer Simulation Tools and Commercial Buildings Performance. He has 30 years of experience in the field of building energy performance, with an emphasis on research, development and deployment of energy efficient technologies and design practices. Projects range from near term demonstrations of emerging technology to basic materials research intended to influence the next generation of building products, and include development of the new computer tools and information technologies needed to change the practice of building design and operations. The program balances a state-of-the-art research effort with an aggressive technology transfer and implementation effort so that results of the R&D program are effectively utilized by industry and the building community. Selkowitz participates in a wide range of building industry, government, and professional activities in the U.S. and internationally. He is a frequent invited speaker on the topic of building energy efficiency, and is the author of over 150 publications and holds 2 patents. His accomplishments are recognized by several awards, the most recent being the 2002 ACEEE Champion of Energy Efficiency Award. Before joining LBNL he was a principal in a consulting engineering firm and taught courses in Environmental Controls and Alternative Energy Systems.*



BUILDING ON A MISSION – SUSTAINABILITY AND GOOD BUSINESS

Sara Fox
Swiss Re

The final phase of the move of all Swiss Re staff into 30 St Mary Axe at the end of April 2004, opened an exciting new chapter for Swiss Re in the UK. While 30 St Mary Axe makes a big impact on the London skyline from an architectural perspective, its innovative design ensures that it will make a minimal impact upon the environment. Corporations worldwide are becoming increasingly aware of their role in society. In this context, Swiss Re is committed to creating economic value, while preserving natural resources and acting responsibly toward society. Swiss Re has adopted sustainability as a core value, and 30 St Mary Axe reflects that commitment.

30 St Mary Axe, located in the heart of the City of London, is a model for the office building of the future. It is London's first environmentally responsible skyscraper.

The specification and design brief for the building was an extremely demanding one. It was to be a world class landmark that would make London proud, providing a first class working environment for our employees, capacity for future growth, an asset for our shareholders and an attractive destination for our clients. We demanded all this in a building that was at the same time environmentally responsible.

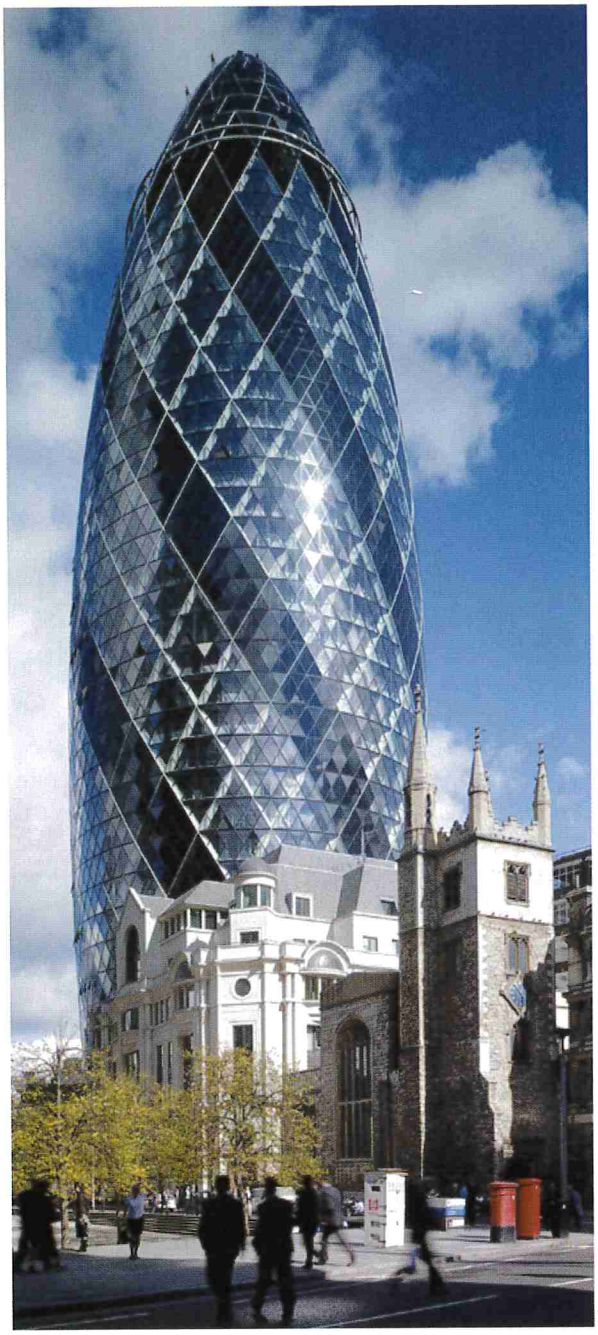
The project team, including leading architects Foster and Partners, rose to the challenge. Working closely with the client Swiss Re and engineering and environmental experts, the architects developed a brilliant design incorporating many innovative energy-saving features.

The tower's aerodynamic shape maximizes the use of natural light and facilitates the use of natural ventilation. The benefits are much reduced energy consumption (up to 50% less energy than a traditional prestige office building) and, at the same time, an enhanced working environment.

Most floors of the 590-foot (180 meter), 40 story building are configured with six fingers of accommodation which are split by lightwells, spanning two to six floors, which maximize natural light penetration. Daylight and occupancy sensors help to minimize electric lighting and reduce energy consumption and cooling loads.

Outdoor views are available from deep within the building. The lightwells draw in fresh air to naturally ventilate the office interiors as they spiral up and reduce reliance on mechanical cooling and heating. The balconies on the edge of each lightwell provide strong visual connections between floors, and create a natural focus for communal office facilities.

Viewed from the outside, the lightwells appear as distinctive spiral bands of dark glazing. 30 St Mary Axe's innovative façade is in fact an internally double-glazed outer skin, an inner screen with inter-cavity blinds and motorized operable windows on the lightwells. The blinds located within the double skin cavity intercept solar gain before it enters the office environment. The intercepted heat can then be reclaimed and recycled or rejected, depending on the requirement at the time for heating or cooling.



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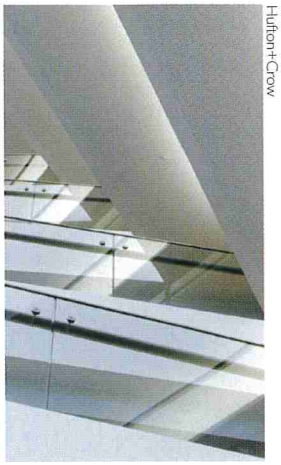


Hufton+Crow

Grant Smith

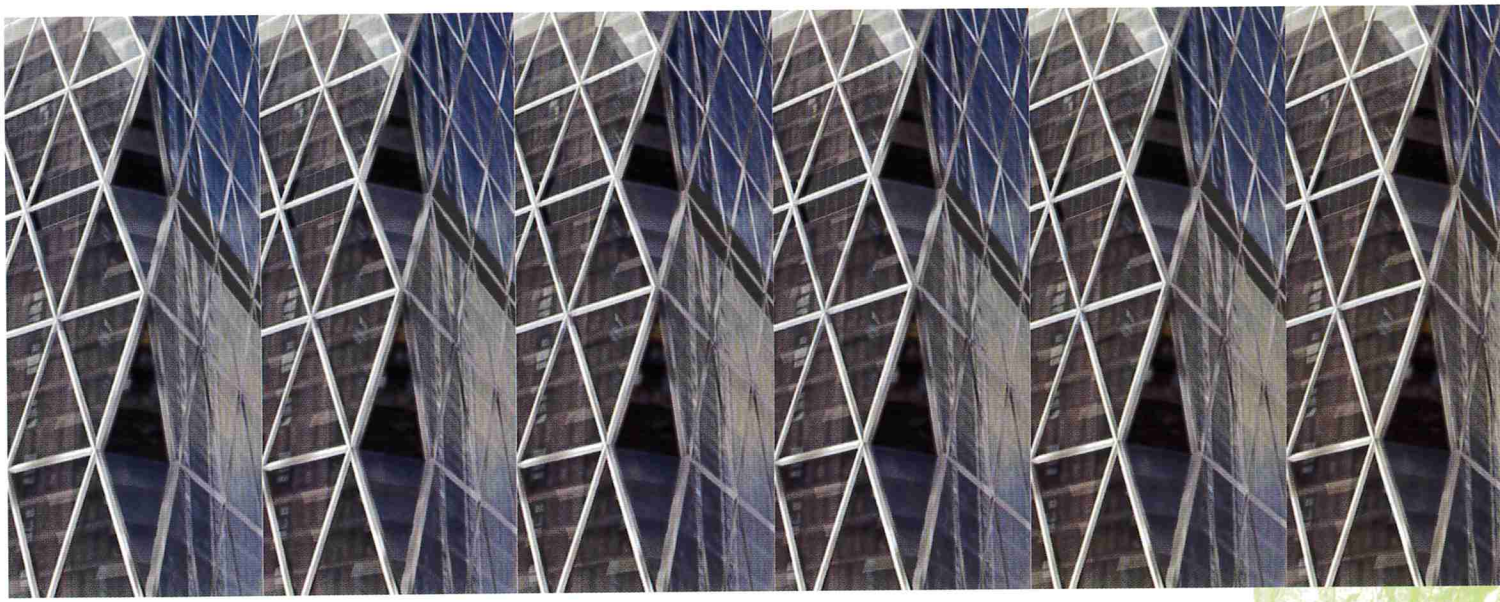
The ventilation system at 30 St Mary Axe is controlled by a series of external weather stations around the perimeter of the building. The precipitation and temperature sensors prevent the windows from opening when it's raining, too hot or too cold. An anemometer measures wind velocity, while another meter measures the intensity of the sun. These devices help control fresh air and dissipate heat to help cool the offices.

Decentralized plants offer the flexibility to supply and control mechanical ventilation on a floor-by-floor basis. By closely matching supply with demand, energy consumption is much reduced compared with a central system for the entire building.

30 St Mary Axe is an extraordinary building that sets new standards in environmental responsibility. Swiss Re has shown that it is possible to create a building that looks good and works well while giving due consideration its impact on the future.

Fluid dynamics studies of the local environment conditions, suggested a strategy for integrating 30 St Mary Axe with its site and allowed it to use the natural forces of wind pressure. The building's circular plan is tapered towards the base and the crown. This improves connections to the surrounding streets, and allows the maximum sunlight to the plaza level. The building's smooth shape also directs air movement around the building. Wind pressure differentials generated by the aerodynamic form, assist natural ventilation through operable windows into the lightwells to supplement air conditioning for up to 40% of the year, reducing energy consumption and carbon dioxide emissions.

Sara Fox *joined Swiss Re in 1995 as Senior Vice President for Relocation. She was responsible for all aspects of building Swiss Re America's 300,000 square foot corporate headquarters in Armonk, NY. In 2000, Ms Fox became New Building Director for Swiss Re Life & Health Ltd. in London. She is responsible for overseeing construction and fit-out of Swiss Re's new UK headquarters; selecting the interior design firm and managing all interiors issues; coordinating retail and commercial leasing; and ensuring the smooth transition from Swiss Re's multiple London premises to the new building. Before joining Swiss Re, Ms Fox was Project Manager and member of the Executive Team of Lloyd's of London. From 1989 to 1992, she held senior roles at Olympia & York Canary Wharf Limited in London, first as Project Executive, Construction and subsequently as Vice President, Administration.*



THE $GREEN$ MATRIX: THE HEARST HEADQUARTERS

Thomas Scarola
Tishman Speyer Properties

For the past two years I have been the keeper of The Matrix. It holds no deep dark secrets or magical formulas but is a process developed to help evaluate the costs of USGBC LEED® certification. The Matrix is a chart that outlines the LEED credit criteria, shows the likelihood of a project achieving that credit and tracks the strategies that might be used to get there. It defines a shifting path, but ultimately points the way to a healthier and more resource efficient building.

The LEED projects I have been working on start with a similar challenge, to achieve a high standard of performance and sustainability in a dense urban setting. Two projects are located in New York City, are over 40 stories and are seeking US Green Building LEED Silver or Gold rating. Two are pursuing the NYS Green Building Tax Credit and one is following the Battery Park City Authority Commercial Guidelines. One of these projects (the first commercial high-rise in New York City to seek LEED certification) is The Hearst Building, a 43-story, 860,000 sf tower at 8th Avenue and 57th Street in midtown Manhattan. Foster & Partners is the lead architect; Adamson Associates, the associate architect; Cantor Seinuk Group, the structural engineer; Flack + Kurtz, the MEP engineers; Steven Winter Associates, the Green consultant; and Turner is the construction manager. Tishman Speyer Properties is the development manager for Hearst.

The Hearst project started with corporate commitments to 1) minimize its building's impact on the environment and 2) enhance the health and well-being of the building's occupants. Along with this came a mandate to prove the value of every dollar spent to achieve these goals. This is where things get harder. Can we consider social conscience in our bottom line? Can we achieve our goals at no additional cost? High performance buildings are usually more expensive to build. The cost of certifying the building through the USGBC LEED rating system is in addition.

There are three main costs an owner must consider: consulting, construction and certification costs. It is essential to analyze costs to identify the expenditures that will provide the best value and decrease the total cost of achieving LEED. Prerequisites are mandatory, but credits can be chosen from a total of 69, so it is possible to avoid or minimize the most expensive.

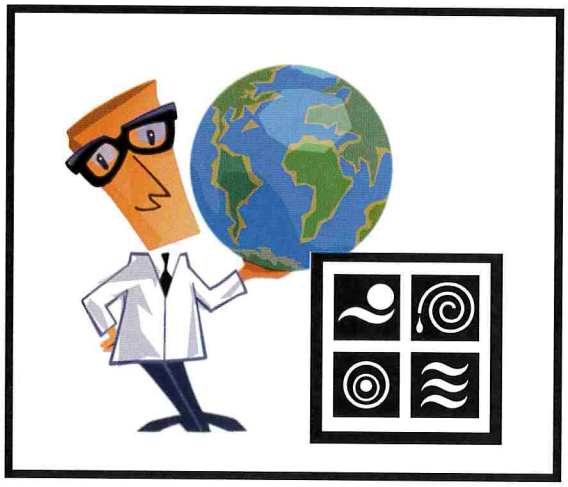
CONSULTING FEES (Soft Costs)

LEED tasks fall on different shoulders from project to project and depend on the skill set of the design team. An owner may find that he need not go outside of the "usual" players, but it is often wise to supplement the team with consultants that can shorthand and streamline the process. This ultimately saves time and money. As the knowledge base becomes broader, the costs for consulting will be reduced. The number of LEED Accredited Professionals is dramatically increasing within design firms, but for now help is usually needed.

The basic design criteria of sustainability will eventually be commonplace, and accepted as a standard consulting service and not at a premium, just as code and life safety enhancements have been. Even now, architectural and engineering firms are expected to have a basic

knowledge and understanding of sustainability and to work with a green consultant who will help the project team incorporate environmentally responsible techniques, technologies and materials. While the learning curve continues to rise sharply, consultants may represent an additional first cost. Regardless, certain credits require expertise beyond the architect, mechanical engineer or construction manager, and it may be necessary to supplement the team. Here are some credits requiring special expertise and time:

Erosion and Sediment Control This prerequisite involves a site specific plan. When possible, it can be written by the civil engineer or green consultant and maintained by the general contractor (GC) or construction manager (CM). It should be prepared prior to the bid package for site work so that it is properly valued. General language, such as the "contractor is to provide …in accordance with the LEED Sustainable Sites prerequisite," assumes knowledge of the standards by all bidders, which unfortunately is still fairly unlikely. On the Hearst project, the plan was developed by the team's Geotechnical Consultant. Execution of the plan will be documented (i.e., progress photos and daily logs) and control measures will be maintained by the construction manager.



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Light Pollution Reduction This credit requires an understanding of lumens and candela values, and its initial evaluation would reasonably fall to a lighting designer. If it is made a requirement within the original scope of the lighting design, it does not have to result in any additional expense. As is often the case with buildings in Manhattan, Hearst decided to forgo this point and contribute to the dramatic New York City skyline.

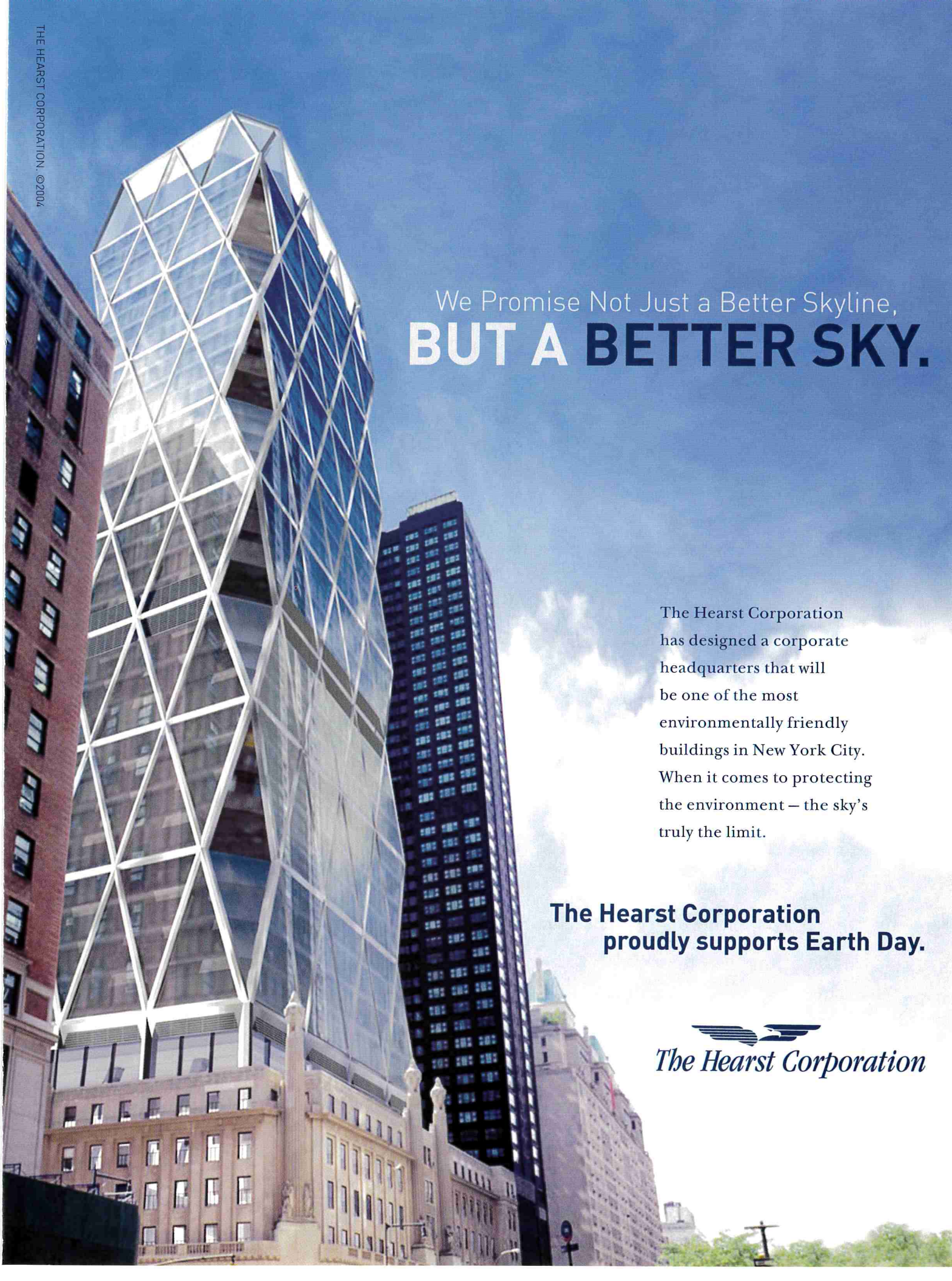
Water Efficiency For these credits, LEED provides templates for many credits that can be completed by anyone with basic familiarity with spread sheets. They help determine, and then verify, that a point can be achieved. We found the templates simple and effective in analyzing the water credits.

Energy and Atmosphere These credits provide the greatest exposure for expense in consulting fees. However, these expenses often provide potential return on investment through reduced operating expenses.

It is possible (although extremely difficult) to achieve as many as ten points by quantifying improved building performance utilizing computer simulation. In this process, a series of mechanical and electrical system alternates are analyzed to minimize energy costs as compared to a baseline defined by ASHRAE/IESNA Standard 90.1-1999. Modeling of the building must be performed by a professional and at considerable expense. Luckily, here in New York State we have NYSERDA (NYS Energy Research & Development Authority) that provides incentives to offset both the expense of the computer simulations and the incremental costs of energy efficient technology.

Commissioning The prerequisite and credit for additional commissioning requires the hiring of an experienced individual not associated with the design of the mechanical and electrical systems. This consultant or Commissioning Authority (CA) performs periodic reviews of design documents to ensure that the design meets the intent of the owner and integrates commissioning requirements into the specifications and bid documents. Ultimately, the CA takes the equipment and systems (after start-up) through a structured and documented process of testing and performance verification. While initially a substantial additional expense, a good commissioning agent can save money by identifying problems in the design stage (when they are much less expensive to fix), avoiding change orders and ensuring the building meets its design intent before contractors have "turned over" the job.

Measurement and Verification This credit is an expensive and confusing credit but projects have been allowed to submit a wide range of approaches. Installing devices without a proper plan for evaluating the data misses the intent of this credit. This credit should be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made the responsibility of the Commissioning Authority and incorporated into the commissioning process. While LEED for New Construction (NC) focuses on design, not operations, the true value of a number of credits can only be achieved with attention beyond construction.

CONSTRUCTION COSTS (Hard Costs)

While soft costs require attention and planning to accurately predict, the primary focus on any project is hard costs. Added design features draw the attention of an owner when they questionably contribute to a building's bottom line. By using the Matrix, an owner sees the strategies and alternative paths to credit compliance and the first cost, energy savings and the operating expenses associated with each choice.

Brownfield Redevelopment Some points are a matter of circumstance rather than an owner decision. A recent LEED Credit Interpretation, discovered through our green consultant's diligence, allows asbestos abatement as an alternate path towards achieving the brownfield redevelopment credit. Hearst is presently researching this credit to see if our asbestos removal will comply.

Alternate Fuel Vehicles. A different CIR developed by another project allowed the owner to avoid the cost of electric recharging stations through the placement of hybrid ZIP Cars (shared cars) to satisfy the criteria for alternate fueled vehicles.

Bike Storage This credit's requirements are based on providing showers and bike racks for 5% of the building occupants. In a high rise commercial context, this is impractical and wasteful. It mandated over 100 racks on the Hearst project and over 500 racks for another project. One company surveyed 10,000 of their employees and found that only one person biked to work. Hearst is presently submitting an alternative path that centers on local subway improvements that will provide handicapped access to train platforms and improve entry conditions that will increase ridership. The approach to improving mass transit has yet to be accepted.

Stormwater Management Calculating how much rainwater will be captured, correctly sizing a containment vessel, and determining the rate of use and volume of reserve are at best, guesses. Adding further complexity, vegetated roofs hold and use water. The goal is to reduce stormwater runoff to the municipal infrastructure. Most common uses include cooling tower make-up, irrigation and utility hoses for wash down. The amount of cooling tower make-up water can be staggering. One project has estimated 20 million gallons of water per year. Nevertheless, due to the current low cost of water at $.0021/gallon, the yearly savings for make-up is only $35,000, assuming a building could even collect that much. At Hearst, with a relatively small roof, we anticipate only being able to capture 25% of our cooling tower needs. The cost of the storm tank, back-up water feeds, pumping, controls, power wiring,

required filtration, chemical treatment of stored water and yearly operating costs and maintenance make simple payback hard to come by. In addition, LEED defines this as a "process load" and does not allow it to be included in the calculations for the Water Efficiency credits.

Water Efficiency These credits can be achieved with low flow fixtures and electronic faucets which are easily available and often used in many of our projects. Those costs should not be attributed to the "green budget". Advancements in technology such as the waterless urinals can actually reduce first cost with less pipe distribution. One of our projects will install a drip irrigation system using reclaimed water; the other will not install an irrigation system at all. Both approaches satisfy the criteria of avoiding city water use for irrigation and will earn this credit.

Energy and Atmosphere The nature of the Hearst project already dictated a high standard of mechanical and electrical design. A highly efficient central plant, economizers, variable speed drives, occupancy sensors, an automated building management system and measurement devices would have normally been included and commissioned. All of the above measures produce acceptable payback and again should not be included in the cost to "green" the project. The addition of daylighting techniques (automatic dimming or shutoff of electric lighting), spectrally selective low-e glass, low temperature air (allowing for lower CFM and smaller air handling units, fans and ducts) and heat reclamation were directly related to improving the building energy performance for LEED and the Green Building Tax Credit.

Hearst uses reclaimed energy from the tower to supplement the conditioning of its lower level public spaces. The building has radiant floors that are either heated or cooled with piping embedded into the floor slab through which hot or cold water circulates. In addition, Hearst uses reclaimed water to supply its atrium water feature that surrounds an escalator that spans three levels. This water is chilled to both offset evaporation and cool the open lobby space.

Commissioning To achieve LEED, fundamental commissioning is a prerequisite. Hearst also chose to pursue the credit for Additional Commissioning, which requires early design reviews. The better job you do at defining the responsibilities of the Commissioning Authority, the Engineer of Record, the Green Consultant and the Construction Manager, the more you can decrease your commissioning costs. Submittal reviews, developing initial control sequences, overall coordination and punch-list completion should not involve the commissioning authority. There are many samples of RFPs for Commissioning services to assist you. The model used by Hearst is available from Portland Energy Conservation, Inc., PECI, at www.PECI.org.

Ozone Depletion For Hearst, this credit was initially considered "Possible" on the Matrix and slowly moved to "Likely" and then eventually "Secure". While the options in non-HCFC refrigerants were clear from the beginning with regard to the large central plant electric centrifugal machines, it was not clear if the smaller back-of-house packaged equipment and kitchen commercial refrigerators would comply. By the end of design development, several manufacturers announced their ability to provide units with alternative refrigerants, and competitive bidding achieved this credit.

Green Power This credit has been influenced by advancements in technology. Initiatives in the field have made wind power a strong commodity. New York State wind is presently more expensive but by "blending" in power from less expensive sources around the country, it is possible to lower the cost.

Construction Waste Hearst retained the entire existing façade of the building and constructed its 43-story tower from the ground up within the untouched perimeter walls; however, no credit was achieved for Building Reuse because LEED requires that 75-100% of a building be retained. Few, if any, projects have ever achieved this. However, we were allowed to calculate the weight of the structure as "reused" in the calculation for Construction Waste Management. Even without this added boost, the carting industry in New York City is regularly able to achieve the recycling of 75% of construction waste with little or no cost premium.

Recycled Content This credit was absolutely achievable with no premium. This was met in large part by the the use of structural steel available made with as much as 95% scrap metal. Steel fabricated in several states within 500 miles also helped greatly in achieving one of the Local/Regional Materials credit. This was a matter of circumstance as much as intent. The award of a significant steel contract would not be influenced by a LEED point.

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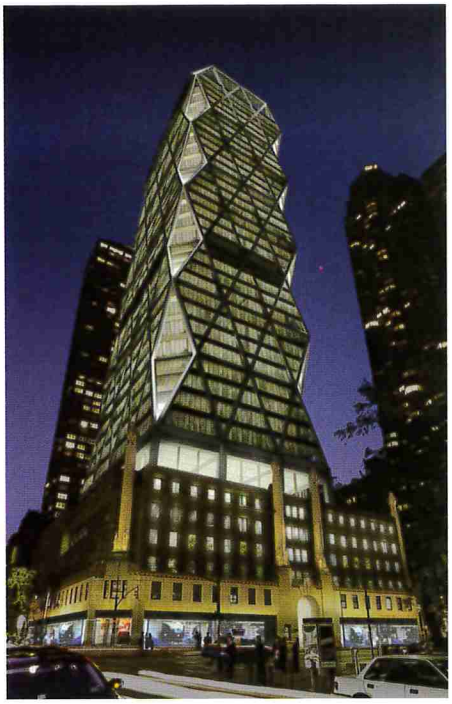

Indoor Environmental Quality
It is through the IEQ credits that LEED provides most benefit to the occupants of a building and provides the greatest potential return on investment to an owner through increased productivity. Hearst is providing smoking rooms kept at negative pressure by dedicated exhaust systems to satisfy the Environmental Tobacco Smoke Control prerequisite. The addition of air humidification will help provide improved thermal comfort in the winter months. A Construction IAQ Management Plan was implemented during construction to protect workers as well as ensure excellent indoor air quality before occupancy. The use of interior glass room partitions provides occupants' access to Daylight & Views.

Innovation & Design Process can contribute up to five points. One is easily achieved by involving a LEED Accredited Professional in the project. The remaining four credits are left to the ingenuity of the design team.

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Adrian Tuluca, RA
Principal

The knowledge of the LEED Accredited Professionals on your team and Green Consultant can usually help secure most of them. The simplest way is to use ideas that have already been approved for other projects or to achieve exemplary performance by substantially exceeding the requirements of an existing credit.

CERTIFICATION AND DOCUMENTATION (General Conditions)

In order to certify a project, fees must be paid to the USGBC. These total approximately $9,000 for any building in excess of 300,000 square feet. Much harder to quantify is the effort needed by the sub-contractors, general contractor, and/or construction manager for research, record keeping, and documentation.

For example, Erosion & Sedimentation and Construction IAQ plans must be validated through jobsite logs and photographs. Low VOCs (Volatile Organic Compounds) and Recycled Content requires collection and review of manufacturer's submittals and Material Safety Data Sheets (MSDS). Some materials require documents that trace the origin of an item or its component parts. Similarly, records of all construction and demolition recycling must be gathered and kept. Hearst took care in developing contract language and had repeated dialogue with potential bidders educating them about the program requirements.

Subsequent projects will need the same attention to contract language, but less time will need to be spent on education as LEED becomes more accepted and understood in the marketplace. Manufacturers have begun to get involved in reducing packaging and clear-

ly documenting the environmental attributes of their products and equipment. These efforts appear to have little cost to the owner. What the owner does have to track is implementation and documentation through construction. On the Hearst project, this resulted in approximately 50% of one person on the field staff for the duration of the project.

The final and most important component of the effort is the person that directly reports to the owner and coordinates the members of the team. This person is generally the keeper of The Matrix. One might think this could be the Green Consultant, but he or she is usually not involved in enough aspects of a project and rarely has access to the cost information. The owner must constantly be kept aware of impacts on the overall costs and schedule. Whether this is an individual on the owner's staff or someone from outside the organization, they must be given the authority to give direction, hold team members accountable and drive the process forward. They also must ensure the proper reporting of costs and avoid the tendencies of either attributing to "green" what might ordinarily have been done or conversely, not recognizing all of the elements addressed here as expenses. Ultimately, the value of LEED certification must be judged by the owner. Before a decision is made to pursue LEED, an owner should understand the basic process, the minimum criteria for compliance, and most importantly, how the process is to be managed.

Thomas Scarola *is the Director of Engineering, Domestic Developments for Tishman Speyer Properties (TSP) located in New York City. He has spent over 30 years in the construction business and prior to joining TSP, was a senior project manager for AMEC/Morse Diesel. He is presently involved in the construction of several large office towers totaling over 4 million square feet, several of which are registered LEED projects seeking certification. Mr. Scarola is an engineering graduate of the University of Notre Dame. He is a member of the National Board of Directors for the United States Green Building Council, serves on the LEED Steering Committee, is Vice Chairman of the LEED New Construction Committee responsible for LEED NC Version 2.2, is on the LEED Commissioning Committee and is a registered LEED Accredited Professional. Mr. Scarola is active with the USGBC New York Chapter, the New York Chapter of ASHRAE, and is a member of both the REBNY Sustainable Urban Development Committee and the New York City Building Department Advisory Committee on Sustainability. As well, Mr. Scarola is a member of the Panel of Neutrals and an experienced Arbitrator for the American Arbitration Association.*

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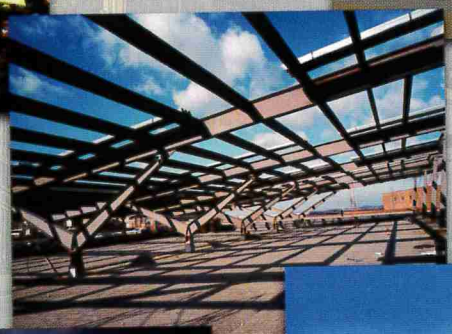

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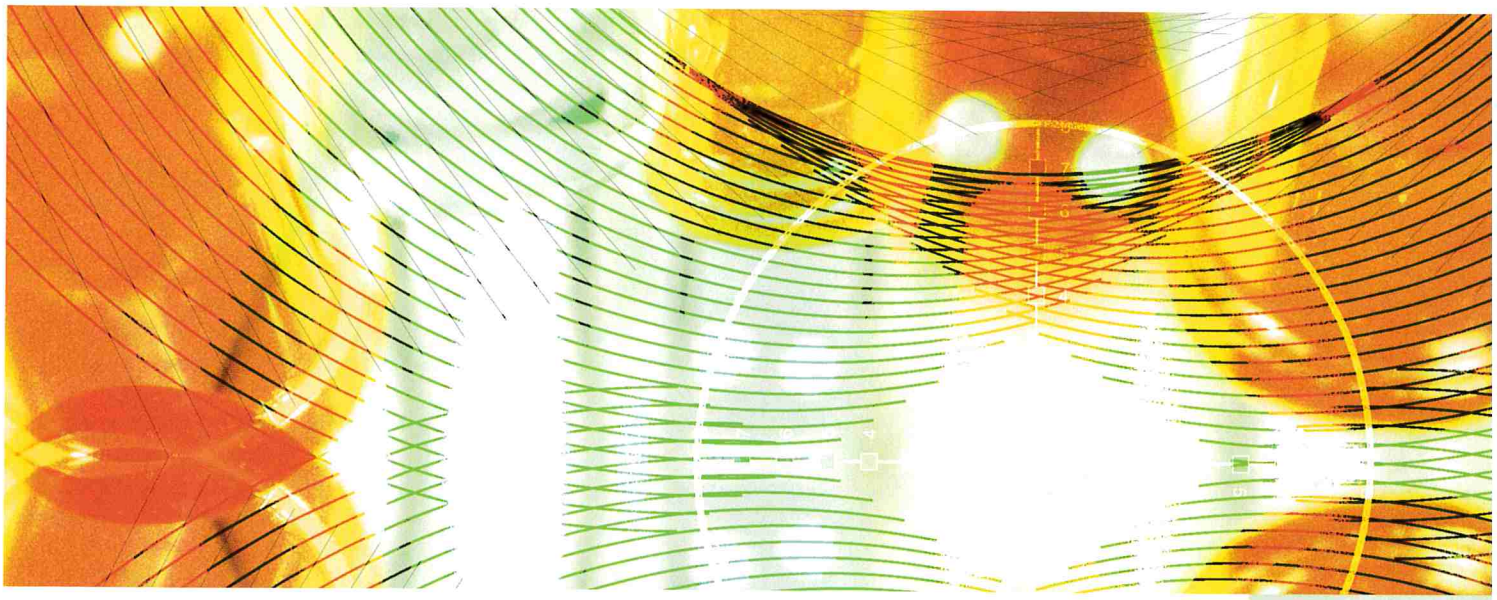

BROOKLYN CHILDREN'S MUSEUM: GREEN BUILDING, GREEN KIDS!

Rafael Viñoly
Rafael Viñoly Architects

Overview

Rafael Viñoly Architects was commissioned in 1999 to build an expansion to the Brooklyn Children's Museum (BCM), located in the Crown Heights section of Brooklyn. Distinguished as the world's first museum for children and founded in 1899, the existing building was designed by Hardy Holzman Pfeiffer and opened in 1977. The $40 million expansion, slated for completion in mid-2007, will add 56,000 square feet to the building. The expansion will double the size of the museum and provide space for more exhibits, educational programs and visitors. It will increase the capacity of visitors annually from 250,000 to 400,000.

Design goal

The BCM intends to become a leader in "green design," promoting environmental responsibility through its physical site, exhibits and programs. Environmental education has long been an important part of the museum's programs for children and families. BCM is slated to be the city's first "green" museum, certified by the Leadership in Energy and Environmental Design LEED® program of the US Green Building Council. On track for Silver LEED Certification, the BCM expects to obtain credit for approximately 37 points.

As the Brooklyn Children's Museum's facility is owned by the City of New York, this project represents a successful partnership between the museum, Rafael Viñoly Architects, ARUP Consulting Engineers, the New York City Department of Cultural Affairs (DCA) and the New York City Department of Design and Construction (DDC). These two city agencies have been invaluably supportive of the project, with DCA helping to secure funding from the City and NYSERDA and DDC lending its oversight and expertise to all phases of the project. BCM is proud to be a part of DDC's Sustainable Design Initiative. The project was recently awarded an honorable mention in the city's first Green Building Design Awards. Construction management is being provided by Skanska Building USA, a firm that has extensive experience in sustainable design projects.

Green approach

Rafael Viñoly Architects believes that "green" architecture or high performance architecture is an integral part of the design process. It stems from a thorough understanding of the building, and an appreciation of the impact any building can have on its surrounding environment and the welfare and health of its users.

During the program and design process, Rafael Viñoly Architects typically establishes criteria that govern how daylight and ventilation are integrated into the design, and how overall building efficiencies can be achieved. These criteria are interwoven with specific program requirements to help formulate strategies for the building structure and systems.

Our design is based on two major philosophies governing the approach to designing a "green" building. The first includes a consideration for building materials, taking into account the building process and the life of the materials.

This extends to specifications that direct the contractor to how waste can be minimized and recycled on the job site. The architect also takes into account the life-cycle costs and energy efficiency of materials and products used in constructing the building.

The second approach stems from a consideration of the building environment and its determinants such as the materials and products used to shape it, the indoor air quality and the quality of daylight in each space.

Often a high performance design approach or "green" building strategy is mandated by the client. With equal frequency, however, within an overall design approach for a specific client, site and program "green" strategies are employed simply by nature of utilizing a problem-solving process that works to achieve an overall efficiency of integrated building systems. For example, we worked to minimize the expanse of HVAC ductwork which helped the museum achieve first-cost savings, reduction in operational heating and ventilating costs, and a better net-to-gross ratio.

We believe that high performance or "green" design does not run contrary to the requirements of managing an institution like BCM. For a museum, optimizing the performance of internal systems helps by maintaining the proper environment for collections and traveling exhibitions.

Site planning
The museum wished to incorporate the environmental aspects of the building as part of its core exhibits. Consequently, the design team paid special attention to the environmental character of the building. While the existing building, essentially a square, was meant to have minimal impact on the street, with much of the building below grade and concealed by planted earth berms, the new addition is designed to reassert the museum's presence within the neighborhood, while being respectful to its site. Not only is the footprint of the new building considerate of existing parkland, but it also offers green areas for public use, thus integrating the museum to the adjacent Brower Park.

A two-story L-shaped building will be constructed along the north and west sides of the current structure – in place of the berms – to accommodate the new program. With its bright yellow façade, the new structure will re-establish the museum's presence at street level as well.

Alternative access
In addition to driving there by car, alternative means of transportation to BCM are available. The museum is located within six blocks of a subway station and bus line and is also close enough to bicycle paths to encourage the use of bicycles. The building program will accommodate secure bike parking location. Increased street signage will also promote pedestrian travel to the museum. On weekends, visitors may ride a free Trolley that stops at a number of other Brooklyn cultural organizations.

Building Design
Close to 100% of the existing museum building structure and shell are preserved and re-used, a design strategy that is both sustainable and economical. The new building's expanded plan and second floor galleries will be integrated into the existing structure by a series of open staircases and vertical circulation cores that will give visitors many more options for moving through the museum.

Sunlight is brought into the building through expansive storefront windows on the ground and second floor. Because of a relatively slender configuration of the building geometry, sunlight is able to penetrate to the deeper part of the museum throughout the year. Without relying heavily on artificial lighting during the day, the building helps to conserve energy with simple architectural design strategies.

The rooftop of the original building will be directly connected to the new visiting exhibition area and kid's café on the second floor, both visually and physically. The existing rooftop will become a future outdoor seating, playing and exhibit area, extending the museum space from inside to outside.

High performance glass
All exterior windows will be made of thermally broken aluminum frames and insulated glass with low-e coating to reduce the heat gain and heat loss through the glazing. Most exterior windows are designed with a deep overhang to further cut down the heat gain due to the direct sunlight going through the glass.

Geothermal heating and cooling systems
BCM will be the first museum in New York City to tap into geothermal wells for its heating and cooling needs. Ground water from a site aquifer that remains at a constant temperature throughout the year is used as a more efficient heat source and heat rejection medium to diminish the building's energy requirements. The total designed cooling requirement for the building is currently estimated to be 300 tons. The total heating capacity is approximately 3,200 MBH. This sustainable system will avoid the use of unsightly cooling towers along with their noise and emissions.

Condenser water for the heat pumps will be provided from two 345-foot deep supply/production wells and pumped directly to heat pump units. 'Spent' condenser water will be discharged also to two 345-foot deep discharge/injection wells. Condenser water will be variable flow with two-port control valves at heat pump units. Each supply/production well will have submersible pump with variable frequency drive. Due to inherent

characteristics of submersible motors, the variable frequency drives will be preset to minimum flow of 50%. A test well was constructed on site in August 2002 and was shown to produce 300gpm.

The museum will utilize three types of heat pumps:

1. Large water-to-air heat pump air handling units: Custom-built air conditioning units complete with water source heat pump refrigeration will be utilized to provide heating, ventilating and air-conditioning requirements for new areas of the building. The air-handling units will also include economizer sections, pre-filters, final filters, DX coil and supply fan. Each air handling unit will have an associated return fan. All supply and return fans will be provided with variable frequency drives for energy conservation.
2. Water-to-water heat pumps will provide chilled water to fan coil units and chilled and heating hot water to the existing air handling unit. The heat pump units were sized to maintain the maximum compressor size below 15hp.
3. Small, console-type water-to-air heat pumps will be utilized to provide supplemental heating and cooling in the stair cores.

Other aspects of sustainable HVAC design include:

1. Two new, modular condensing boilers will be provided to serve the existing finned tube radiation on the East and South façade and the existing hydronic heating in the greenhouse. The peak heating load for this hydronic system is approximately 240 MBH.

2. "Free-cooling" coils in the air handling units are utilized so that at peak cooling loads, the coils would pre-cool air, thus reducing the overall compressor size. And at part-loads, the coils would provide reduced compressor run-time requirements.

3. Each air handling unit will have multiple refrigeration circuits (two minimum) with individual heat exchangers. Maximum compressor size will be 15hp.

4. All air distribution systems will be designed to maximize zone control and ventilation effectiveness.

5. Selected perimeter zones will be provided with electric reheat coils at the VAV boxes.

6. Motion, photoelectric and carbon dioxide sensors will control the performance of the ventilation, ensuring the comfort of the museum's visitors while reducing energy consumption.

7. The museum's ventilation system will be automatically adjusted to accommodate the number of visitors in each space at any given time through the use of carbon dioxide sensors and a sophisticated building monitoring system.

8. No HCFC's or halons will be used as a refrigerant for HVAC equipment.

Photovoltaic and electrical system

It is the museum's intention to integrate the PV panels as an educational highlight within the museum's program. With a grant from the New York State Energy Research and Development Authority (NYSERDA), the New York Power Authority (NYPA) has identified BCM as one of the two public buildings in New York to support the development of commercial grid-connected photovoltaic (PV) systems.

PV panels integrated into the building design will convert solar energy directly into electrical power. The new museum will be equipped with two groups of south and east facing PV wall arrays with an estimated aggregated power of 15kWdc each, for a total of 30kWdc.

Each wall array will generate approximately 9,000 kWh of electricity per year, for a total generated power output of 18,000 kWh annually. It is estimated that solar energy captured through PV panels on the museum's exterior walls could provide about 1.28% of the electricity the museum will need each year.

The PV System will be connected to the building power distribution system via a 70 amp circuit breaker located downstream of the connection from the utility. The power requirement for the expected occupancy is estimated to be approximately 12 VA per square foot. The completed project will require a total of 1030 KVA of electrical power.

Sustainable lighting design strategies:

1. While providing appropriate foot-candle levels to create a safe environment, interior and exterior lighting is designed to avoid light pollution leaving the building site.

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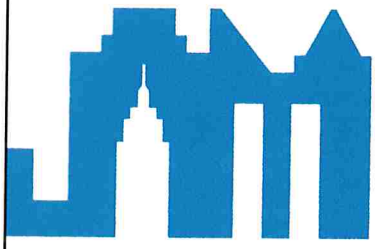

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Christopher Hazel,
Vice President

2. Motion occupancy sensors will control the lights in offices, staff bathrooms and other public rooms.
3. Photoelectric sensors will regulate the amount of artificial illumination in public spaces according to the amount of natural light at any given time.

Energy and building system management
The museum is equipped with a fully integrated Building Management System (BMS), incorporating Direct Digital Control (DDC) for energy management, equipment monitoring and control, including color graphic workstations. The BMS will provide control and monitoring of the building systems and functions such as HVAC equipment, carbon dioxide monitoring, temperature control and the geothermal system.

Economics
The New York Power Authority is providing approximately $250,000 towards the cost of the photovoltaic panels and energy analyses. The New York State Energy Research and Development Authority is providing $500,000 of financing for the geothermal heating system and other high-performance features. The museum estimates a savings to the City of New York, which owns the building that houses the museum, of $103,000 per year in energy costs.

Integrated environmental exhibits
Concurrent with the architectural design development, BCM is developing plans for a series of site-specific, interactive exhibit stations that demonstrate energy concepts that are inherent in the design of the facility expansion and bring the "green" systems to life. Development of these exhibits will bring together the expertise of exhibit designers/artists with architects/engineers/energy specialists, and provide an opportunity for a partnership between BCM and environmental groups, public agencies and utilities. Selected designs will be prototyped with children ages 5 to 12 to assess interest and educational value. The educational goals of the exhibits will be to:

1. Engage children and their families with fun, physical and interactive experiences that can raise awareness of their relationship with the environment.
2. Create a layer of exhibition components integrated with the expanded facility that prompt active explorations of energy generation conversion and uses in daily life.
3. Support the development of environmental awareness and social responsibility.

Conclusion
The Brooklyn Children's Museum expansion presents unique opportunities for environmental education for children and adults alike. The museum seeks to strengthen this unique concept as part of their new expansion by incorporating state-of-the-art, high performance architectural and engineering practices into the facility design. By demonstrating leadership and social responsibility through prowess of sustainable architectural and engineering design, the expanded Brooklyn Children's Museum will become a national leader in educating children and families about the positive impact of "green" building, sustainable design, and making environmentally-friendly choices in their everyday lives.

Rafael Viñoly, *FAIA/JIA/SCA, founded Rafael Viñoly Architects PC in 1982 in New York City. The firm has offices in Lower Manhattan and London and employs more than 170 people. In Rafael Viñoly's nearly 40 years of practice in the United States, Latin America, East Asia and Europe, his work has been driven by the belief that architecture's essential responsibility is to elevate the public realm. His deepest focus is on maximizing the opportunity for real civic investment that every construction project brings. Viñoly's work has been recognized by numerous design excellence awards including the AIA Medal of Honor. He became a Fellow of the American Institute of Architects in 1993 and is a member of the Japan Institute of Architects.*

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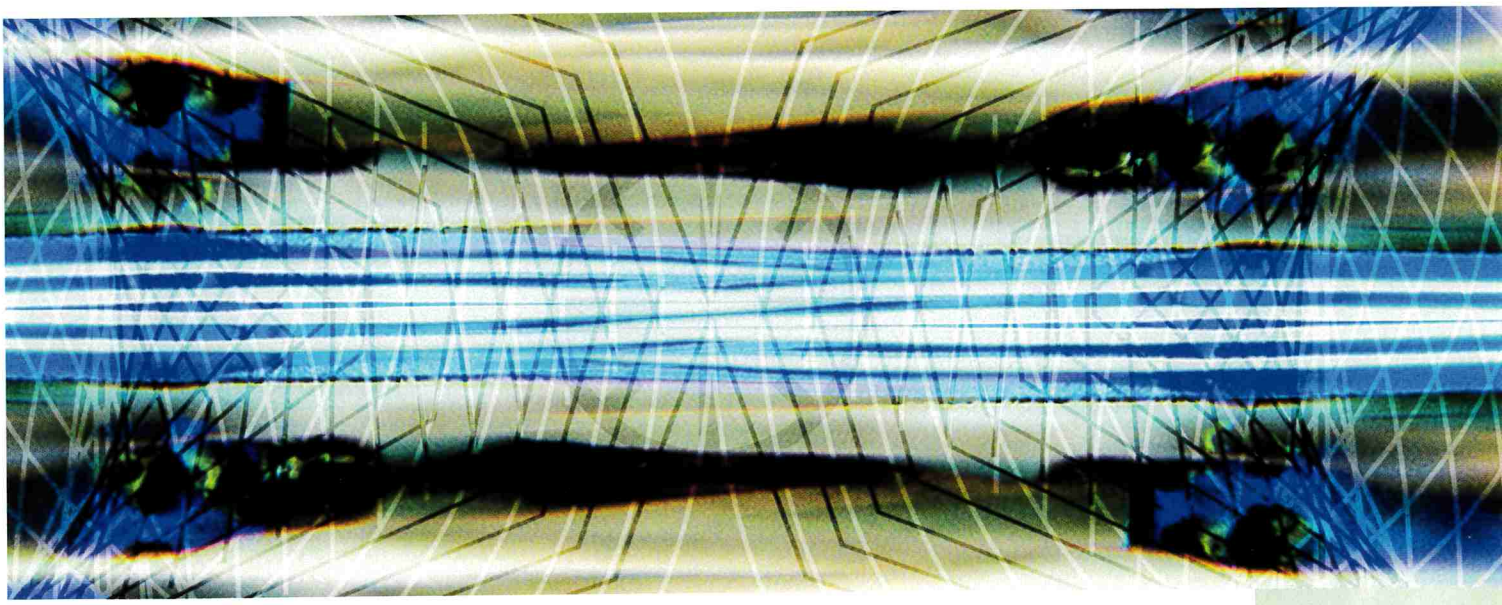


CLEARVIEW ELEMENTARY: A HIGH PERFORMANCE LOW COST SCHOOL

John Boecker, AIA
L. Robert Kimball & Associates Architects
7group

L. Robert Kimball & Associates utilized integrated design strategies to design this new 43,450 SF high performance K-4 elementary school, completed in December 2002, for the Hanover Public School District. It achieved LEED® Silver Level Certification from the US Green Building Council (USGBC) within a conventional school's construction cost budget. The following outline provides a detailed description of characteristics, objectives, goals, benefits and outstanding attributes of the project.

Project Goals, Process, and Involvement of Internal and External Stakeholders

The design process for Clearview Elementary school explicitly targeted the integration of the physical environment with the learning environment and the community. This process commenced with a series of community meetings that included parents, administration, facilities staff, faculty and designers. These meetings established the overarching goal for the school's design: to create a place of learning that inherently teaches students, faculty and the community about environmental stewardship and responsibility, while augmenting both building and student performance.

Targeted design priorities included provisions for copious natural daylighting, excellent indoor air quality, significant reductions in energy consumption and minimizing the use of non-renewable resources and materials. The school was designed so that the building itself serves as a teaching tool about environmental issues, particularly illustrating lessons about sustainability and how indoor environmental quality (IEQ) can enhance learning. All involved participants understood from the beginning that these intentions would result in a healthy educational environment that expressed the community's environmental aspirations and neither looked nor felt like an ordinary school. The project received grants totaling $35,500 for additional design services, including energy modeling, daylighting modeling and commissioning from The York Foundation Energy Program and the Met Ed Sustainable Energy Fund.

Integrated Design

The project was designed utilizing a focused systems integration process in order to minimize redundancies between building systems, maximize their efficiency and thereby downsize or entirely eliminate systems components. This integrated design process incorporated computer-simulated energy modeling utilizing PowerDOE software, systems and materials selections based on life cycle analysis (LCA) comparisons produced on BEES software, detailed LCA analysis utilizing the Athena Environmental Impact Estimator software, and computer-simulated daylighting analysis/simulations utilizing Radiance and Skycalc software.

Building Location and Context

The building is located in Hanover, PA, on the periphery of Hanover's urban core, a fully mixed-use neighborhood with adjacent sites occupied by retail, manufacturing and residential uses. Access via public transportation lies within 150 meters of the project and access by private vehicles is very easy with no congestion. Prior to

Key High Performance Green Design Features

Highlights associated with this project's high-performance green design include:

- Passive solar strategies optimized building orientation along an east-west axis.
- Sundial integrated into the structure's curved south-facing sun-screening wall.
- High-albedo Energy Star roofing materials reduce "heat island" effects.
- Exterior lighting designed to eliminate light pollution with no light trespass off-site.
- Water consumption reductions of 39% relative to the Energy Policy Act of 1992.
- Underfloor supply air plenum air distribution coupled with ground source heat pumps.
- Pre-conditioned energy recovery ventilation provides system dehumidification.
- Heat recovery air-handling units separate ventilation air from conditioned air.
- Reverse-baffle solar shading devices and overhangs shade south-facing windows.
- Lighting power density averages 0.97 watts/SF, or 33% less ASHRAE 90.1-1999.
- Daylighting design with photocell sensored dimming and occupant sensors.
- Daylight factor exceeds 2.0 in all regularly occupied classrooms.
- High performance thermal envelope including R-25 insulated concrete form (ICF) walls.
- High performance triple-glazed, low-e, argon filled windows that eliminate perimeter heating systems.
- R-30 roof assembly incorporates integrated Homosote structural decking with 100% recycled content.
- Flexible manufactured cabling distribution system underfloor for power voice, and data.
- Fundamental best practices Commissioning Plan implemented.
- Permanently installed equipment monitors energy consumption and air quality.
- Annual energy consumption cost reduction of 59%, as modeled relative to ASHRAE 90.1-1999.
- Construction Waste Management Plan diverted 90% of construction waste from landfill disposal.
- Over 20% of building materials by cost contain high recycled content.
- Over 60% of building materials by cost were manufactured locally.
- Over 6% of building materials by cost qualify as rapidly renewable, primarily via wheatboard millwork.
- Blended cement concrete utilized blast furnace slag to displace 40% of Portland cement.
- Selection of low-VOC solvent-free paints, adhesives, sealants, and coatings throughout.
- Floor-mounted air-distribution diffusers provide 100% ventilation efficiency.
- Thermal comfort compliance with ASHRAE 55-1992.
- Specifications required implementation of a Construction IAQ Management Plan.
- Carbon dioxide sensors in all classrooms and primary spaces.

construction, the site was a vacant lot adjacent to the existing elementary school, a building that is retained fully intact for other occupants. The site is nearly flat with a maximum 3% slope and vegetation consists primarily of grasses. All existing trees remain undisturbed; therefore, minimal site disturbance was required. The site also possessed pre-development infrastructure for all utilities, adequate for satisfying the project's base and peak loads with minimal impact on existing capacity. Potable water use will have no effect on long-term aquifer capacity.

The project also exploited the high degree of locally and regionally manufactured building products available.

Relationships between Design Strategies and Site Context

In addition to the site-related issues mentioned above, the following design strategies further link the project with its site. The building was precisely oriented longitudinally along an east-west axis, thereby providing due north and south exposures to all primary classroom functions in order to

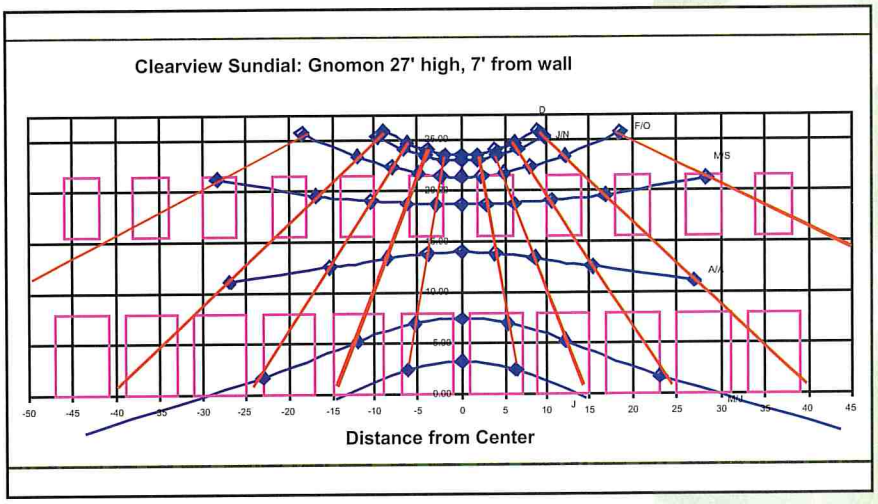
maximize daylighting provisions, reduce heat gain/heat loss, and to utilize the single-loaded corridor on the south side as a passive solar collector. This corridor is shaded strategically by exterior "reverse baffle" solar shades and a curved solar "screen wall" that doubles as a functioning sundial for student study of solar phenomena. Accordingly, classrooms primary windows face due north, with south-facing clerestory windows (comprised of diffuse glazing) facing south. A large existing asphalt paved playground was demolished, and its paving material was ground on site and utilized as granulated fill for the new project. New play areas include a pervious surface area. Paved parking areas were held to a minimum, below zoning constraints. Landscaping utilized indigenous grasses requiring no irrigation.

The curved solar screen wall described above also creates an acoustical backdrop for a large secure exterior amphitheater sized to accommodate the school's entire population for exterior assemblies and programs. Soil structure investigations allowed the utilization of highly efficient multi-zoned ground source heat pumps that supply heating and cooling. Locally harvested and milled untreated rough sawn hemlock wood siding references the materials of nearby 100-year-old barns in this agricultural region.

Performance Information

The building was modeled utilizing PowerDOE energy modeling software. As modeled, it will consume 23,658 Btu/sf/yr, or a 69% reduction when compared to the ASHRAE 90.1-1999 compliant benchmark of 75,881 Btu/sf/yr. In terms of energy cost, this equates to $0.62/sf/yr, or a 56% reduction when compared to the ASHRAE 90.1 compliant benchmark of $1.40/sf/yr. Computer generated daylighting simulations also were modeled for the project's primary spaces, utilizing Radiance software. The following graphs depict example outputs of daylighting levels in typical classrooms for January and May under clear sky conditions:

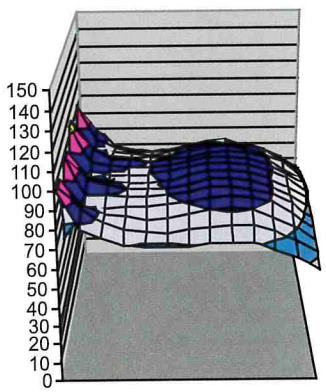
Additionally a mock-up model was built to analyze the effects of the curved solar screen wall and integrated sundial as depicted below:



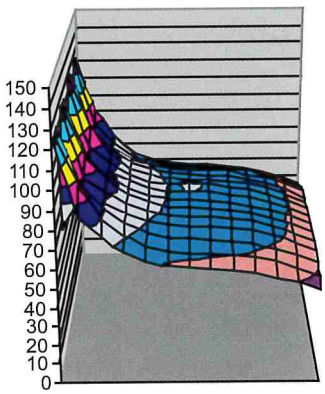
Results

The design team's goal for the project, established prior to commencing schematic design, was to achieve LEED Silver Level Certification with an energy cost savings of at least 40%. Further, this was to be accomplished at or near conventional school construction costs. The resulting project cost slightly less than the average cost of all elementary schools built in the same year in Pennsylvania, and LEED Gold Level Certification was achieved. Modeled annual energy savings equate to over $34,000 per year; when multiplied by the building's anticipated 30 year life, these energy savings equate to a total of $1,020,000 in today's dollars. An integrated design process involving all team members was the methodological approach employed to accomplish these results. This approach utilized the synthesized creativity of all systems' designers and the simulation tools described above. In addition, this school was one of five projects nationwide selected by the U.S DOE to

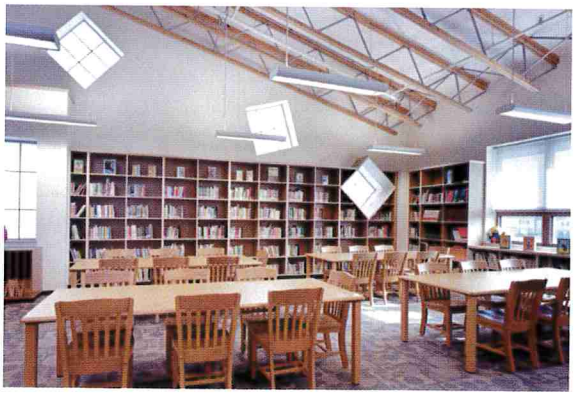
Clearview, Windows/clerestories, 1/21, 11 am, Clear Sky



Clearview, Windows/clerestories, 5/21, 11 am, Clear Sky



Photos: Jim Shafer



represent the United States at the international Green Building Challenge 2000 (GBC), Sustainable Building 2002 Conference in Oslo, Norway. Accordingly, this project engaged in extensive data analysis utilizing the GBTool, an extraordinarily elaborate spreadsheet assessment of comprehensive performance relative to systems performance, resource consumption (including embodied energy), environmental loadings, indoor environmental quality, service quality, economics and pre-operations management. This project also has been honored and distinguished by the following:

- First public school in Pennsylvania to achieve LEED Certification (second in U.S.)
- 2003 AIA Design Award Citation for Design Excellence
- First Prize for "Places of Learning" from The Northeast Sustainable Energy Association's 2003 Design Awards
- One of the 4 Design Award winners in *Environmental Design + Construction* magazine's 2003 Design Awards
- Published as featured high performance green school in *Environmental Building News*, *Environmental Design + Construction*, and cover story for *School Planning and Management*
- Featured building in the U.S. Department of Energy's web site High Performance Building Database of "Buildings of the 21st Century": www.highperformancebuildings.gov
- 2004 Sustainable Buildings Industry Council (SBIC) National Exemplary Sustainable Building Award, Second Place
- Video highlighting this project produced by American Environmental Review, hosted by Morley Safer, broadcast on PBS

Project Construction Costs

Hard construction costs for Clearview totaled $6,310,623. This equates to $145.23/SF, or $0.10/SF less than the average construction cost of $145.33/SF for all elementary schools constructed in the same year in PA, according to the Pennsylvania Department of Education's "Calendar Year 2001 Costs of New Schools Based on Bids" report, dated 7/31/02. It should be noted that the construction cost above excludes moveable fixtures and equipment and design fees; it includes all site development costs.

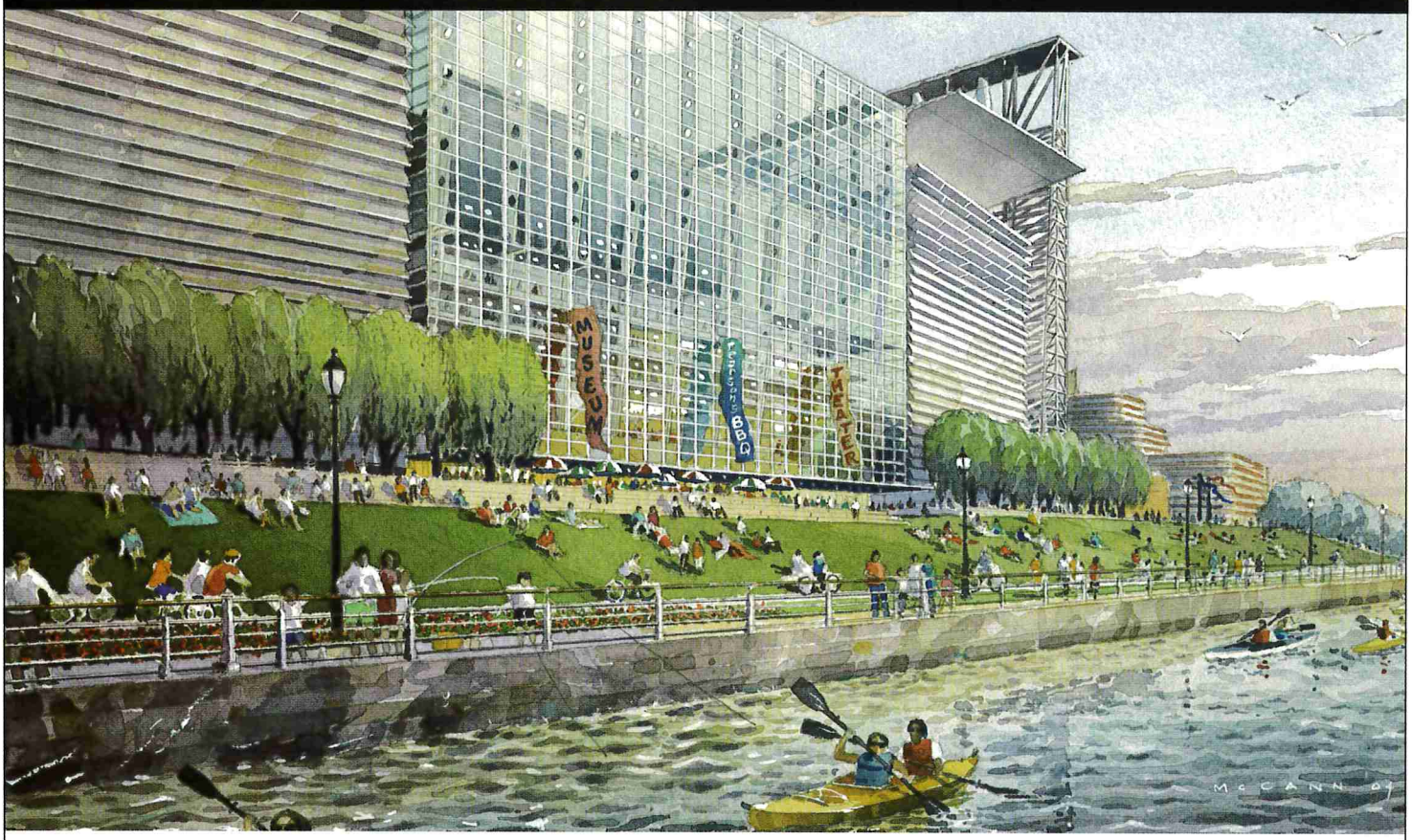
Photo: Jim Shafer

John A. Boecker, *AIA, currently serves as a partner in 7group (www.sevengroup.com), a green building consulting firm, and as Vice President, Director of High Performance Green Design for L. Robert Kimball & Associates Architects and Engineers, where he concentrates his architectural practice on designing high performance green buildings as a LEED Accredited Professional. He also serves on the U.S. Green Building Council's (USGBC) National LEED Steering Committee, as Chair of the LEED Curriculum & Accreditation Committee, as Chair of the Green Building Association of Central Pennsylvania (an Affiliate of the USGBC), and teaches LEED Advanced Workshops as an appointed LEED Faculty Member with the USGBC. He has practiced architecture in New Haven, Pittsburgh and Los Angeles.*

Mr. Boecker has designed four LEED Certified buildings, including two of the first 15 buildings nationwide to achieve LEED Certification from the U.S. Green Building Council, and the first to receive Gold Level Certification under LEED Version 2.0. His design work has been recognized by over 40 design awards. Mr. Boecker holds a degree in Architecture from Penn State and a Master of Architecture degree from Yale University.

NY SPORTS AND CONVENTION CENTER

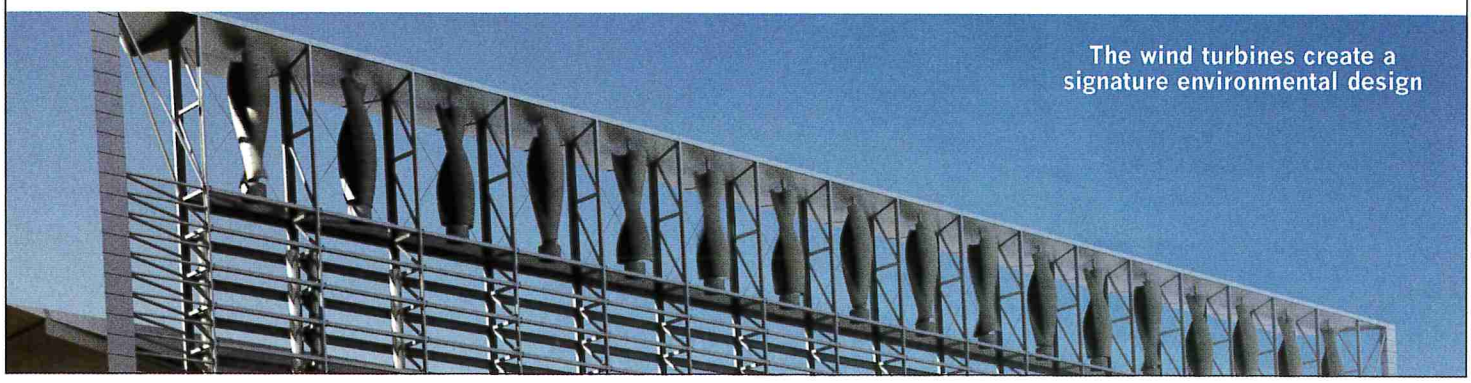
The New York Sports and Convention Center is more than just a football stadium; it is a unique multi-use facility that will attract the best sports, convention, entertainment and cultural events from around the world while offering the community amenities such as shopping, cafes and parks.
With an $800 million private investment from the Jets, the NYSCC is a critical component to remake the Hudson Yards into a vibrant mixed-use neighborhood by connecting to the waterfront, expanding the convention center, and spurring new residential and commercial development. The NYSCC will create new jobs and new tax revenues to secure the economic future of New York.



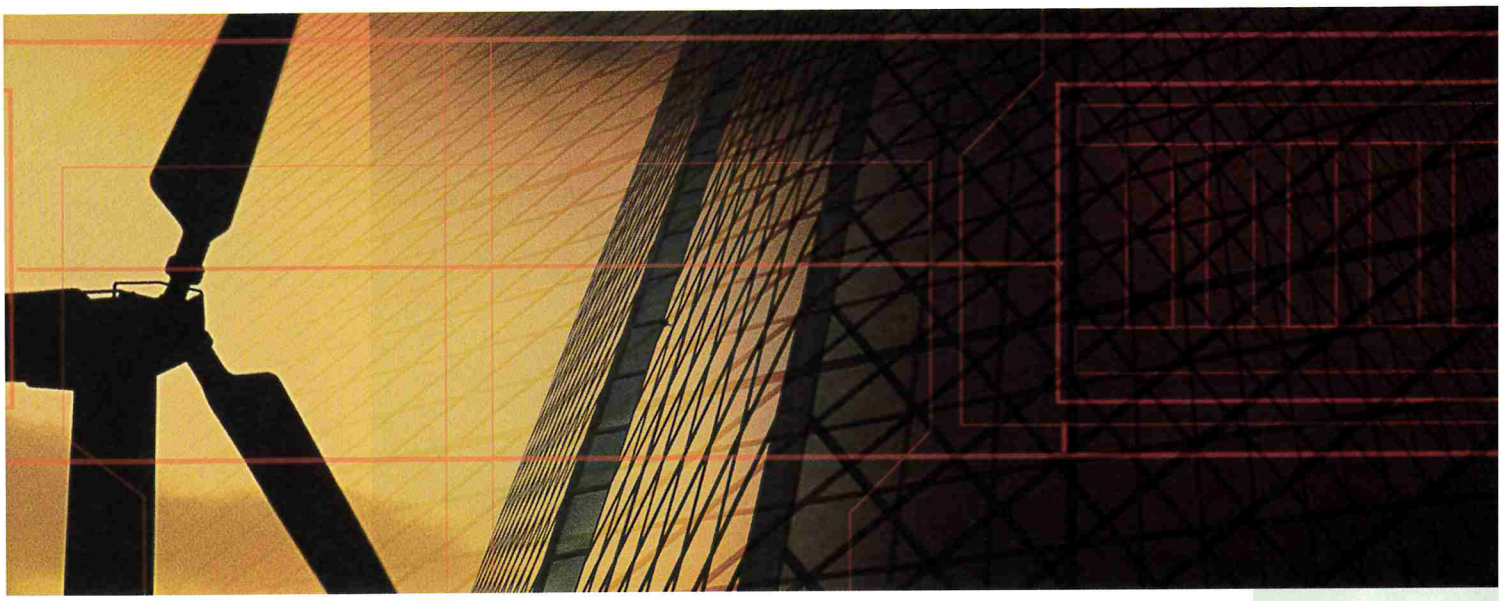
A TRULY GREEN BUILDING

The New York Jets are committed to making the New York Sports & Convention Center the most environmentally-advanced building of its kind -- setting the highest standards for renewable design and sustainable development. To achieve that goal, the NYSCC generates power from renewable sources of sun, wind and rain - harnessing renewable resources whenever possible for its daily operations. Active and passive ventilation will cool the air in the building. Rooftop rainwater collection, filtration and re-circulation will conserve water consumption. This water will also used in the numerous water features which are being incorporated into the landscape design.

The NYSCC's location on the edge of the Hudson River is ideal for wind generated power. Taking advantage of this opportunity and highlighting the sustainable nature of its entire design, the building features 34 vertical-axis wind turbines on the upper edges of the north and south walls of the structure. This type of wind turbine is sculpturally elegant and highly efficient in transforming wind energy into electrical energy generating enough electricity for all football game use. With wind turbines, solar panels and the ability to recycle rainwater, the NYSCC will be the most environmentally friendly stadium in the world. We hope its example will inspire the design of future buildings.



The wind turbines create a signature environmental design



ARCHITECTURE, ENERGY, URBANISM: DESIGNING THE NEW CONVENTION CENTER

William Pedersen, FAIA, FAAR
Kohn Pedersen Fox Associates

With the construction of the New York Sports and Convention Center (NYSCC), Manhattan will finally acquire the capacity to host the biggest conventions and sporting events. The NYSCC is designed to operate as an arena, plenary hall, stadium and 200,000 gsf convention center. Seating capacities of 75,000 for football, 40,000 for basketball and 85,000 for Olympic configurations make it possible to host the Super Bowl, the NCAA Final Four Championships and Olympic Track and Field, all in one building.

The New York Jets have made sustainability an important part of the design process from the earliest stages. The Jets are committed to making the NYSCC the most environmentally-advanced building of its kind – setting the highest standards for renewable design and sustainable development. To that end, the NYSCC has been designed to minimize its impact on the environment by harnessing renewable resources whenever possible for its daily operations.

Active and passive ventilation will cool the air in the building. Rooftop rainwater collection, filtration and re-circulation will conserve water consumption. Thirty-four wind turbines, each 40' tall and crowning the edges of the roof, will generate enough electricity for all of the football games. This will minimize the building's impact on local power sources and the environment as a whole. With wind turbines, solar tubes and the ability to recycle rainwater, the NYSCC will be the most environmentally friendly stadium in the world.

The NYSCC's location on the edge of the Hudson River is ideal for wind generated power. To harvest this energy, 34 vertical-axis wind turbines will be placed on the upper edges of the north and south walls of the structure. This type of wind turbine is sculpturally elegant and quite silent in its operation. In addition, it is highly efficient in transforming wind energy into electrical energy. These turbines become, in effect, the building's signature. Their kinetic qualities seem to be highly symbolic of the athletic contests contained within.

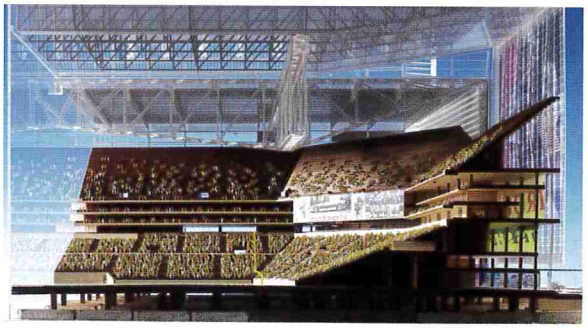
The south wall will be infilled with solar tubes which can provide all of the hot water requirements for the building. In addition, these solar tubes act as a sun screen device, shading the public concourses along the south side of the building.

Rain water will be collected on the roof of the building, filtered within the landscape areas and then held in cisterns for use as grey water in the building. This water is also used in the numerous water features which are incorporated into the landscape design. The NYSCC's location next to the Hudson River has inspired us to utilize rain water as a primary feature of the landscape – water in movement, never still or stagnant. Water is not only reserved and re-used, it is also conserved through the installation of waterless urinals throughout the stadium.

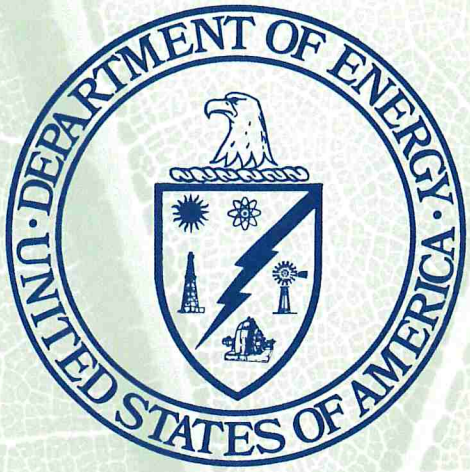
Finally, large quantities of trees are planted to offset the amount of carbon produced by the facility's minimal

traditional energy consumption, while providing green and shade to the public spaces. Used solely as a football stadium, the initial objective of creating a "carbon neutral" or a "carbon negative" structure was achievable with the sustainable components described. Now, however, this stadium has been designed to be a multi-use facility. The building incorporates the elements which allow transformation of its seating from a stadium to a convention center within a twenty-four hour period. This is the stadium's most dramatic feature and promises to make it the leading sports and convention venue in the world. This metamorphic capability extends the use of the facility from 15-20 stadium events per year to over 150 events held within the stadium, plenary and exposition hall configurations. If the Olympics come to New York in 2012, the design can easily expand to meet the 85,000 seats required for the Olympic configuration by creating a western extension across West Street towards the river.

Buildings currently represent over forty percent of global energy consumption. A dramatic reduction in this number must become an urgent worldwide priority. This facility is the dominant component in the development of the Hudson Yards and we hope its example will inspire the design of future buildings. The entire structure is seen as a "power plant" capable of harvesting sustainable sources of power. This image has significant aesthetic possibilities, which have been utilized to their full potential. The architecture team derived an aesthetic from sustainability, which is inherently beautiful and will be, without doubt, the future direction of architecture.



William Pedersen *is the Principal Design Partner of Kohn Pedersen Fox Associates PC. KPF has earned the Architectural Firm Award by the American Institute of Architects (1990) and the Gold Medal of Honor by the New York Chapter of the AIA (1989). Mr. Pedersen has received five National Honor Awards from the AIA for the New Academic Complex, City University of New York/Baruch College (2003), the World Bank in Washington, D.C. (1998), Westendstrasse 1/DG Bank Headquarters in Frankfurt, Germany (1994), the Procter & Gamble World Headquarters in Cincinnati (1987) and 333 Wacker Drive in Chicago, Illinois (1984). Other major projects include the World Financial Center in Shanghai, the Gannett/USA Today Headquarters in Virginia and the New York Jets Stadium in Manhattan. Mr. Pedersen received the Gold Medal for Lifetime Achievement in Architecture from Tau Sigma Delta, National Architectural Honor Society. Additional honors include the Arnold W. Brunner Memorial Prize for Contributions in Architecture as an Art (1985), awarded by the American Academy and the Institute of Arts and Letters; the 1990 University of Minnesota Alumni Achievement Award and the Rome Prize in Architecture (1965), awarded by the American Academy in Rome.*



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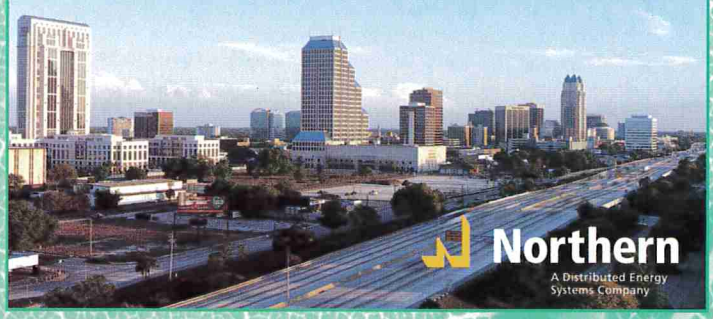

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LIVING GREEN IN A GOLD BUILDING

George Aridas
Albanese Development Corporation

Symbol of Sustainability

At the southern tip of Manhattan, in the community known as Battery Park City, rises a new, 27-story residential building, called The Solaire. The building is located just two blocks north of the site of the World Trade Center complex and was under construction on the day of the horrific events associated with September 11th. As the first building to rise from the ashes of the neighborhood, The Solaire symbolizes the indomitable spirit of New York that is beginning the journey of rebuilding downtown Manhattan. Its completion represents the collective efforts of the private and public sectors; of finance and labor; and of design professionals and non-profit advocates. It is this focused, collective effort that is rebuilding lower Manhattan as a beacon for the future.

The Solaire is the first high-rise residential building in the country to achieve a LEED® gold rating. That honor, officially awarded in April 2004, is the culmination of a twelve-month design and eighteen-month construction effort, interrupted for nine months by the tragedy and subsequent events of September 11th. Throughout that interval, the entire design team and the officials and staff of the Battery Park City Authority (BPCA) maintained an unshakeable commitment to achieving a green residential building of the highest quality and performance that would demonstrate the principles of sustainability.

It Began with a Vision

In 1999, seeking to advance the environmental vision and priorities of Governor George E. Pataki, Timothy S. Carey, the Chief Executive Officer of BPCA, proposed a new concept for future development of Battery Park City. "We knew that the large scale of our projects had the potential to push the market toward improved environmental practices. Battery Park City was a great place to try it," says Tim Carey, speaking of the decision to promulgate the Authority's Residential Environmental Guidelines. The Guidelines were completed in late 1999 and were incorporated as part of a request for proposal (RFP) released in January 2000.

One of over two dozen developers that attended the public meeting to hear about the RFP, the Albanese Organization, Inc. saw an opportunity and a challenge worth pursuing. Long committed to creating and owning quality projects of enduring value, we saw potential for a market of environmentally aware professionals who would respond eagerly to a housing option that offered a healthier, more comfortable living environment in a building that made fewer demands on the biosphere.

In preparing our response to the RFP, we assembled a team of design and construction professionals that included: Cesar Pelli and Associates; Schuman Lichtenstein Claman Efron Architects; Green October; Cosentini Associates; Steven Winter Associates; and Turner Construction Corporation. Each of these firms had experience in development of green buildings. More importantly, each had a commitment to the goal of demonstrating that environmentally advanced buildings are feasible in the highly competitive Manhattan real estate market.

Partnerships and Progress

In June 2000, at the conclusion of a very competitive

process, BPCA designated the Albanese Organization, Inc. as the developer for what was then known as Site 18A. While the end of the solicitation process, it was only the beginning of the iterative and innovative design process. In remembering the excitement of beginning the effort, Russell Albanese recalls, "Our goal was to create a building that exceeded the objectives presented in the Guidelines. We envisioned residences of extraordinary comfort and convenience that promoted energy efficiency and a healthier living experience – a building that raised the bar – but we knew there were many challenges ahead of us."

Among the challenges were the following:

- This was to be the first building designed in accordance with the BPCA Guidelines.
- It was the first residential high-rise that would seek LEED certification. (The Commercial Guidelines had to serve as the guide because no residential guidelines then existed.)
- It was to be the first green residence in New York City, whose innovations in water recycling, fresh air-circulation and photovoltaic panels presented new technological challenges to a Buildng Code intended for traditional residential buildings.
- It was to be designed to achieve the new New York State Green Building Tax Credit, although those guidelines were being developed at the same time as The Solaire.

Designing any green building, especially one seeking to achieve so many "firsts", called for a holistic and participatory approach, vastly different from the normal design process. The design team met weekly, investing time in research and thorough analyses. In between meetings, there was a steady stream of communication and information sharing among team members and outside support groups. Design and construction options were evaluated for quality, financial performance and expected resident demands and preferences. These evaluations were often guided by use of computer modeling techniques, including DOE-2 models. The result was an iterative design that refined and modified variables to achieve optimum results along a continuum of performance parameters.

The Battery Park City Authority was active throughout the design process, participating with the Albanese team in a mutually beneficial and collaborative process. We were greatly assisted by BPCA staff and leadership as they often served as a catalyst for change, advocating for green innovations with City, State and Federal agencies responsible for code enforcement and other administrative duties. Similarly, BPCA staff appreciated our commitment to sustainable principles and willingness to go beyond the letter of the Guidelines. Subsequent versions of the Guidelines have been strengthened to reflect many steps taken in the design and construction of The Solaire that exceeded the original measures.

Valuable assistance was also provided by State and Federal agencies, as well as environmental non-profit organizations. For example, the NYS Energy, Research and Development Authority (NYSERDA) provided both technical assistance and financial incentives that paid for much of the DOE-2 analysis and evaluation of design alternatives. The US Department of Energy provided information on products and techniques, while the Natural Resource Defense Council assisted in exploring many of the energy and design options early in the design process.

A final and very key partnership was formed with Northwestern Mutual, which became our joint venture partner on the project. Their commitment to sustainable design and long view of real estate was in harmony with the life-cycle perspective inherent in valuing green design. They were a natural partner for Albanese, and as events unfolded after September 11th, their commitment and resoluteness contributed immeasurably to seeing the project through to completion.

Re-Dedication to the Effort

Construction began in April 2001. By September 11th, the foundation had been excavated and the concrete was being poured for the first floor when the World Trade Center towers were attacked. Given the site's proximity to Ground Zero, work was immediately halted and the cranes were redeployed for use in assisting recovery and clearing efforts at the World Trade Center site. In November, when the contractor was again able to have access to the project, the first floor slab was completed and the site was secured and closed.

The cooperative relationship between Albanese and BPCA was renewed as we collectively sought ways to restart the project and begin the rebuilding of downtown. While the Authority, Albanese and our partner, Northwestern Mutual, remained committed to the project and maintained our optimism about the long-term outlook for Battery Park City, the financial institutions and primary lender had trepidations about the economic feasibility of the project. The next eight months were devoted to negotiating with various financial institutions and seeking alternative sources to enable the project to resume when the original lender would not agree to finance the project.

What ultimately proved to be the alternative financing was approved by Congress in February 2002, as Liberty Bonds. Before the bond program was fully implemented, we resumed construction in July 2002 and eventually received an allocation of the bonds from the NYS Housing Finance Agency, whose coop-

eration and expedited action enabled us to continue construction without additional interruption.

The key point to note is that throughout this hiatus and seeming non-stop negotiation and exploration of alternatives, there was never any consideration given to abandoning the green goals for the building or altering the Guidelines. In some respects, the devastation that occurred, and the desire to build something even better, made the green objectives more compelling.

Making it Green

The BPCA Guidelines set forth recommendations in five areas of design: energy efficiency; indoor environmental quality; resource and materials conservation; operations and maintenance; and water conservation. As with all green design efforts, attaining these targets required consideration of these issues from the beginning of design. Added to the mix were the market imperatives of designing living spaces that would be well received by the potential occupants. The building had to be green, but it also needed to be inviting, comfortable and appealing. In the end, marketability and sustainability were complementary, not competing goals. As an example, to meet energy and indoor air quality goals, The Solaire has a four-pipe, fan coil, central HVAC system that filters 90% of particulate matter before introducing fresh air into each habitable room. The air is conditioned, humidified in the winter and dehumidified in the summer. The system achieves many green objectives, including a 65% reduction in peak load electric demand. At the same time, it provides a degree of controllability and comfort, along with a healthier living environment that resonates well with prospective renters and has greatly contributed to the success of The Solaire.

The HVAC system is but one of the many sustainable and innovative features incorporated within this unique residence. The box below is a summary of the sustainable features that contributed to the Gold rating.

Dollars and Sense

The Solaire contains 293 rental residences, with over 55% of the apartments containing two or three bedrooms. The residences in this family-oriented building average 1,040 s/f, considerably larger than the average Manhattan rental unit. Ceilings in most living spaces are 8'6", also greater than average, and the floor to ceiling windows provide exceptional natural light and offer breathtaking views of New York Harbor and the Statue of Liberty.

The construction cost of The Solaire was higher than traditional residential buildings. Some of this was due to the higher quality finishes, and some is attributable

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Image courtesy of Jeff Goldberg/Esto

to incorporation of the green features. A common question is, "how much extra does it cost to develop a green building?" A simple answer is, "it depends upon how green." That reply masks a great deal of truth. The incremental cost depends upon the type of building, the size, occupancy and goals sought to be achieved. The incremental cost to develop a green high-rise residence may be greater than the cost to develop a low-rise residential building, and greater still than the incremental cost to construct a green office building (compared to a traditional commercial building). In the case of The Solaire, we estimate that the environmental features (including the black water treatment system and associated plumbing) added about 17% to the hard costs.

However, the question of costs in isolation misses the point of sustainable design and enduring value. The costs are an investment in quality, and the question of success is whether the investment has long-term value. As noted in the previous section, sustainability and marketability are often complementary. About 70% of the incremental green costs are associated with features that improve comfort and health of the occupants.

The marketing material developed for the building highlighted the sustainable nature of The Solaire, inviting people to "live healthy, live green." We stressed the energy savings that would be enjoyed by the occupants, the cleaner indoor air quality that would be afforded by the materials used in construction and the central air filtration system, and the degree of individual environmental controls provided by the daylighting and temperature controls installed in their residences. These features were much appreciated by potential renters who toured the apartments at The Solaire, and resulted in above market rents and achievement of full occupancy in a short time. Our leasing office opened in April 2003, beginning operations in the construction trailer while the building was being completed. The first tenants moved in during the first weekend of July 2003, and five months later the building was 90% leased, a remarkable pace for an extraordinary building.

Green design requires a holistic approach, and it is not advisable to evaluate features in isolation. Nevertheless, from an investment perspective, the initial rents achieved were about six percent higher than those being achieved in residential buildings in the immediate area. This increment, if sustained, is sufficient to justify the green incremental investment for features that can be classified as contributing to the comfort and health of the residents. Moreover, from the unsolicited positive comments we continue to receive from tenants about the observable improvement in the respiratory conditions of their children, we believe the turnover of apartments will be lower than traditional apartment buildings, producing additional maintenance savings and lower vacancy costs.

Phasing in Green – The Lessons Learned

The Solaire is a success story with many public and private contributors to that success, and there are many lessons that can be taken from the cooperative efforts.

The first lesson is that green buildings can be developed competitively in Manhattan, and the public will respond positively to a green choice. This was the spirit underlying the formulation of the BPCA Environmental Guidelines as expressed in the earlier quote from Tim Carey.

The second lesson, which can be supported by any development team that has developed sustainably, is that the process requires an open mind, open communication and the willingness to explore the interaction of all building components and design decisions. The goals must be enunciated early in the process and must guide subsequent decisions.

Third, green development, while becoming more accept-

What Makes It Green?

- A centralized HVAC system that incorporates double effect natural gas-fired absorption chillers, variable speed pumps, fans and motors for improved efficiency and lower peak electric demand;
- Centralized air filtration and seasonal humidity adjustment, with supplemental filtration within the residences that removes up to 90% of the particulate matter from the air;
- Photovoltaic cells integrated into the façade and capable of generating 5% of the building's base electric load;
- On-site treatment of all waste water, and recycling for cooling tower make-up and toilet flushing;
- A separate system for stormwater collection, filtration and reuse for irrigation purposes;
- A highly insulated and sealed building envelope with a high performance window system and separate vapor barrier;
- Occupancy sensors in common spaces, such as hallways and stairwells, and master switches within the apartments to encourage energy conservation;
- Programmable, digital thermostats;
- High-performance, operable low-e, insulated casement windows;
- Energy Star fixtures and appliances;
- A rooftop garden open to residents at the 19th floor and a green roof on the 27th floor, both designed to reduce the heat island effect, reduce stormwater runoff and contribute to the buildings insulation.

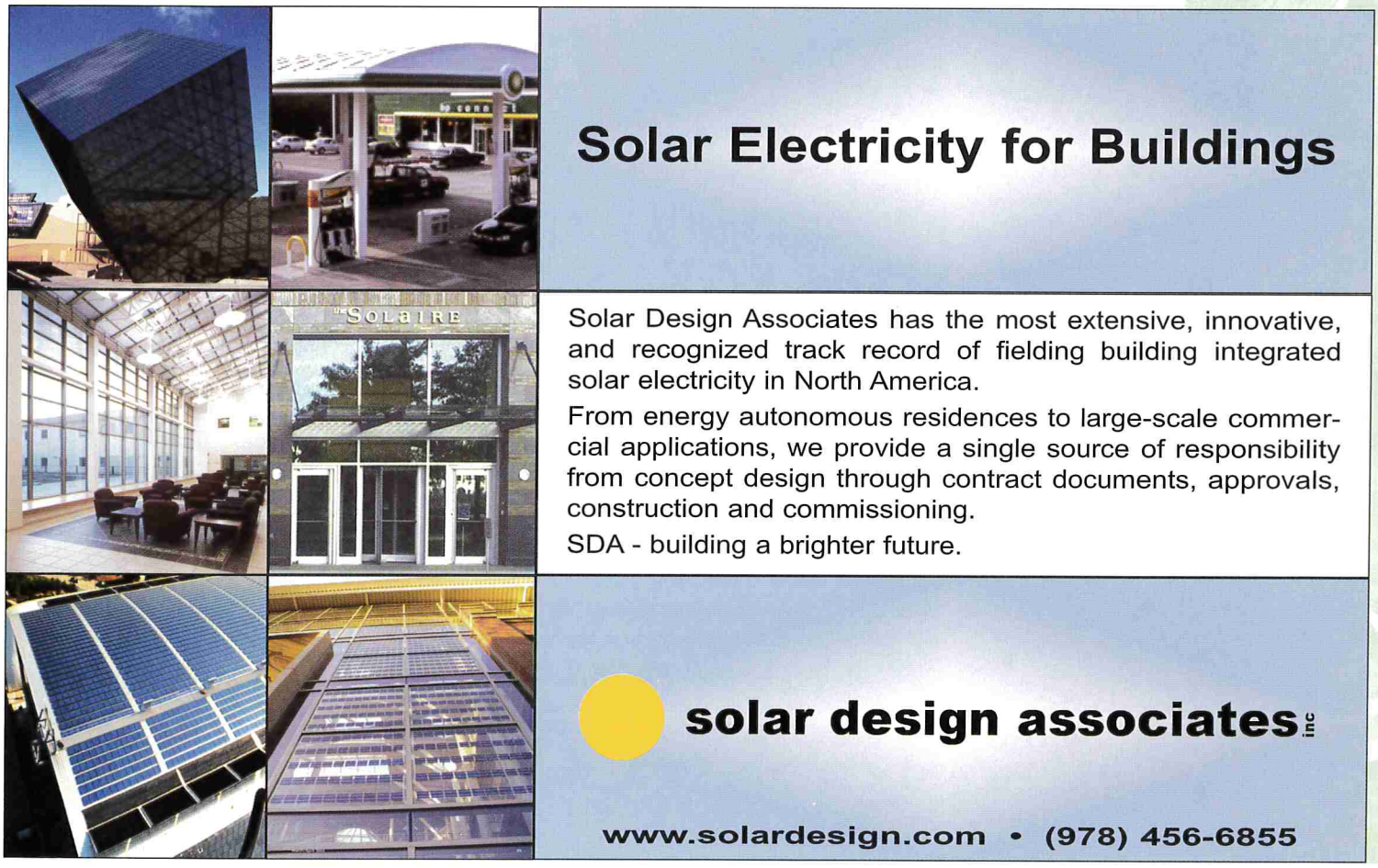
ed, is still in the vanguard, and its successful completion requires the cooperation of the public and private sectors. The Solaire demonstrates that tax and other economic incentives can mitigate some of the initial costs, while fostering an economic environment that lowers the cost of subsequent buildings while raising the bar.

Fourth, sustainability must be maintained. While sustainability must be designed into a building, the commitment cannot stop with design. The principles must be carried through construction, commissioning, operation and on-going education and communication with occupants. While many recognize the steps that must be taken during construction and understand the importance of commissioning the building, the importance of communicating with the occupants, whether workers, residents or visitors, is often underestimated. Particularly in a residential context, where interaction with the building is 24 hours a day, 7 days a week, the habits, activities and actions of the building occupant can enhance or undermine the sustainable goals of the building.

Our entire management staff is dedicated to the sustainable goals and is committed to resident education and communication. In seeking to maximize the benefits that the residents experience from the features of The Solaire, we supplemented and enhanced our personal communications with the residents by instituting an on-line capability linked to residents' own computers. This system provides information about building systems, advises of filter changes or other maintenance efforts the staff will be conducting, informs residents of more environmentally friendly cleaning products, and generally seeks to foster a sense of common purpose in which the residents accept and participate in the sustainable environment that is their vertical community.

We are very proud of The Solaire and are gratified that the residents have noticed and spoken about the improved indoor environment, general healthier feeling and dedicated staff. We have benefited from their feedback, and have internalized the lessons learned in the design of our second green tower in Battery Park City, which is under construction as of this writing.

George P. Aridas *is a Senior Vice President of Albanese Development Corporation, with responsibility for location and acquisition of projects for the firm, performing the financial and feasibility analysis, particularly for projects in the public and institutional sectors. Prior to joining the he held a number of public positions including head of Queens West Development Corporation and Executive Director of the NYC Environmental Control Board Aridas holds a B.A. in Urban Affairs from Hunter College; an M.P.A. from Baruch College and a Certificate from the NYU School of Real Estate.*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THE HELENA: ACHIEVING LEED IN MULTIFAMILY URBAN RESIDENTIAL HOUSING

Craig Wasoff, Rose Associates, Inc.
Pamela Lippe, e4, inc.

When The Durst Organization, well known developers of class A office towers, decided to build their first residential high rise, they engaged Rose Associates, Inc. to help manage the project. Rose Associates is experienced in developing and managing first class residential properties and offered the perfect complement to the Durst Organization's expertise in commercial and environmentally responsible development. Together, they began The Helena, a 38 story, 600,000 sf residential tower at 11th Avenue and 57th Street.

The Dursts hired architects Fox & Fowle; mechanical and structural engineers, Flack + Kurtz and Severud; and for construction management, Kreisler Borg Florman (KBF). With support from the New York State Energy Research & Development Authority (NYSERDA), e4, inc. was hired to evaluate energy options for the project and assist with the implementation and documentation of LEED®.

The Durst Organization is unusual in its commitment to environmentally responsible development and its willingness to invest in new technologies before they may be completely cost-effective. The Helena has a black water plant, a PV array on the bulkhead and canopy and a combined heat and power plant.

This case study will illustrate how one project team (with the assistance of several specialized consultants) navigated the challenge of applying a LEED standard essentially developed for owner-occupied office space in a suburban context to a high rise residential building in a densely urban neighborhood. The lessons learned are broadly applicable, because LEED is a less than perfect fit for many building types, and creative approaches are often needed.

Erosion & Sedimentation Control

Most erosion and sedimentation control plans focus on avoiding erosion of topsoil, but on a densely urban site there is little or no topsoil. Our plan and efforts focused on preventing pollutants from leaving the site using runoff control berms, dewatering filtration, truck wash down and dust control.

Alternative Transportation, Alternative Fuel Vehicles & Parking Capacity

LEED currently rewards carpooling and gives credit for 208V or 240V, 40 amp electric charging stations for electric cars that are largely obsolete. In response to our credit interpretation request (CIR), LEED approved specifying 120V, 20 amp outlets for NEVs (Neighborhood Electric Vehicle) for 3% of The Helena's parking capacity. In addition, we provided wiring to accommodate higher voltage to "future proof" our proposal, but specified no charging hardware. We also proposed, and they approved, defining hybrid vehicles as alternative fueled vehicles. The hybrids will be provided by ZipCar for rent (by the day or by the hour).

Car sharing provides additional environmental benefits and our LEED ruling was subsequently reapplied by another New York City project to substitute for the carpooling requirements. Carpooling doesn't make much sense for residential projects, especially in New York City

with its extensive mass transportation system. Car sharing is convenient, reduces car ownership and decreases the pressure for more parking spaces.

Vegetated Roofs and Blackwater Plant
LEED makes no mention of blackwater plants, but they can be extremely helpful in achieving a number of points. To achieve the stormwater reduction credit, LEED requires a 25% decrease over pre-development conditions. The Helena's black water plant, along with green roofs on the 2nd, 8th, 11th and 39th floors will capture most of the stormwater runoff. The Helena is achieving a 75.4% reduction which should give us an innovation point at no additional cost.

LEED requires the removal of 80% of Total Suspended Solids (TSS) and 40% of the phosphorus in rainwater runoff to achieve the stormwater treatment credit. Removal of phosphorus makes sense in rural or suburban settings, but is rarely found on urban sites. Nevertheless, a low or no phosphate building wide cleaning and fertilization plan will be developed to maintain the intent of the credit.

Recycled Water
Treated black water is being used to flush toilets and irrigate the vegetated roofs on the 2nd, 8th, 11th and 39th floors. We had to segregate collected stormwater to irrigate the ground level due to local health regulations preventing the release of fully treated black water into the ground. This requirement seems a bit absurd when you consider the number of dogs that are walked daily on city streets, but is typical of the complications often posed by local codes.

Much of the recycled water will be used for cooling tower makeup. In New York City, buildings use billions of gallons of potable water a year for this purpose. Unfortunately, LEED changed their position in the middle of our project about whether this savings can be applied towards the water efficiency credits. They do recommend applying for an innovation point for process water savings which could provide an additional point.

Water Use Reduction
We were able to test and choose faucets and shower heads that delivered lower gallons per minute (gpm) than required by code while providing the user better pressure than is typically found in low flow fixtures.

Combined Heat and Power
The Durst Organization has been exploring co-generation or Combined Heat and Power (CHP) for many years. At the Helena, we are installing two 70kW natural gas fired microturbines that will provide power to base building mechanical equipment and lighting. Flack + Kurtz sized the system to provide enough waste heat to supply all the building's domestic hot water. The plumbing system design and selection utilizes storage hot water heaters in order to capture the continuous heat output from the microturbines. This technology helped secure several credits for the project for energy optimization.

Photovoltaics
Unfortunately, photovoltaics still do not make much economic sense. The Dursts continue to experiment with them on their buildings whenever possible to help promote the industry and to become more experienced with their installation and operation. At the Helena we have over 15kW of photovoltaic panels integrated into the bulkhead and canopy. Until PV gets less expensive, it will not be economically viable in a high rise building to meet LEED's minimum goal of 5% total energy use. The Solaire, a residential high rise in Battery Park City, was able to produce 5% of the base building use, but that is not currently the LEED requirement.

Measurement and Verification
LEED details the systems that should be monitored to achieve the Measurement and Verification credit in commercial buildings, but provides no guidance for residential buildings that usually have substantially different systems. At the Helena, we are monitoring lighting systems and controls, constant and variable motor loads, variable frequency drive (VFD) operation, air distribution static pressures, ventilation air volumes, boiler efficiencies,

process energy efficiency systems and equipment, indoor water risers, outdoor irrigation, air and water economizers and heat recovery cycles.

Materials
Recycled Content, Local/Regional, Rapidly Renewable, Certified Wood & Low Emitting
In a building of this size, it is critical to look first at the materials that will be used in the largest quantities. Most of the LEED materials credits require the project to meet a 5% minimum threshold compared to the cost of all materials. Making sure you receive the cost of materials broken out in the contractor's bids from the beginning will save a lot of headaches in the end.

Concrete
In the last few years, the use of blast slag in concrete has become increasingly accepted in the New York marketplace. Our structural engineer, Severud, specified a concrete mix containing 45% blast slag. We found that concrete made with slag sets up faster and acheives a higher early strength, while still providing excellent workability.

Steel and Aluminum
Steel, aluminum and most other metals normally used in construction will often provide high levels of recycled content. The tricky part is getting the subcontractors to accurately trace it. If the steel comes from a mini-mill, it is likely to be 100% recycled. Other mills may provide varying amounts of recycled and virgin material. It is becoming easier as the industry has had to respond to demands from LEED projects all over the country, but again, early and regular communication with your contractors and detailed reporting requirements are essential.

Drywall
Up until fairly recently, drywall was available with recycled paper facing but was otherwise made from virgin gypsum. Again, probably in response to market demand, the major drywall companies have begun to make the product from 100% recycled gypsum. We were lucky enough to find two major suppliers who had plants within 500 miles of New York City assisting us in achieving one local and regional credit as well.

Flooring
Finding environmentally responsible finish flooring proved to be one of the most difficult challenges of the project. With 300,000 sf of wood flooring area and oak parquet as the industry norm, it was extremely difficult to find an environmentally responsible substitute anywhere close to our budget. We started looking at the many variations of bamboo, then researched foreign and domestic products from managed forests. Unfortunately, with most options, we were looking at a million dollar upcharge. A domestic engineered FSC-certified oak plank product was finally selected. In addition, we used rapidly renewable materials such as linoleum and wool carpeting in several other applications.

Rapidly Renewable Materials
Being unable to select a bamboo product for our finished flooring, we knew that we would not be able to attain the "rapidly renewable" materials credit at the current LEED requirement of 5% of the cost of all materials. Nevertheless, we chose to retain our initial selection of linoleum and wool carpeting, closet bifolds and kitchen and bath cabinetry constructed with a wheatboard core. The wheatboard material tested very well for low emittance of harmful pollutants, but we could not use it for shelving as it demonstrated a stability problem.

Environmental Tobacco Smoke (ETS) Control
The ETS prerequisite had already engendered a considerable amount of controversy by the time we began to look at it. The required protocol was based on ASHRAE 129-1997 which was developed to measure ventilation effectiveness in mechanically ventilated buildings. Most apartments are required by code to have operable windows and are therefore considered "naturally ventilated." In addition, ASHRAE 129 requires impermeable deck-to-deck partitions, negative pressure to surrounding areas, and very expensive tracer gas testing in 10% of the apartments. We were advised that a residential building had a high probability of failure based on the current LEED protocol.

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With the assistance of Ambient Group, Inc, our indoor air quality consultant, we proposed a less expensive test that achieves the same purpose, by gasketing and sealing our demising walls and maintaining a positive pressure in our public corridors. The proposal was accepted by the LEED Steering Committee and submitted as an alternative compliance route for residential buildings only.

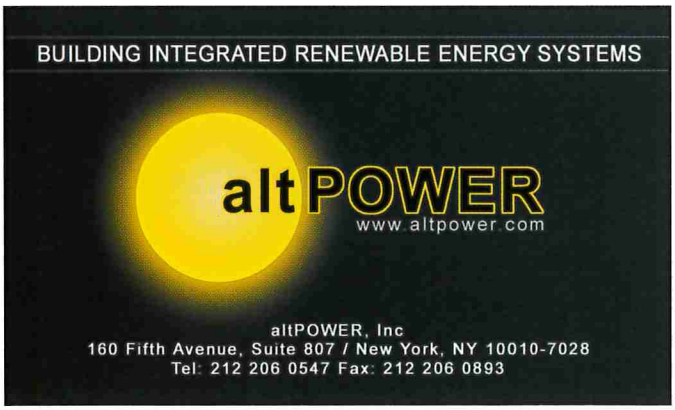
CO/CO_2 Monitoring

LEED had already recognized that CO_2 monitoring was not appropriate for most spaces in residential buildings since occupancy is normally low in apartments. An alternative path had been approved based on a CIR from a building that was pursuing the NYS Green Building Tax Credit (GBTC). They proposed a testing protocol required by the GBTC that was ten times more expensive than our approach that still achieved the intent of the credit. LEED accepted our proposal.

Indoor Environmental Quality

A Construction IAQ Management Plan was developed for "during construction" and will be extremely important due to the phased occupancy of the building. Careful attention will be paid to separating the construction from the tenanted spaces. All ductwork and openings will be kept sealed. In addition, no equipment will be started up until the commissioning process is underway. The maximum available MERV (Minimum Efficiency Reporting Value) filters were specified and will be changed often when used, and immediately before occupancy.

With the support of Ambient and Horizon Engineering, our commissioning agent, we went back and forth on how to achieve Post-Occupancy Construction IAQ credit but based on schedule and security issues, decided against a flush-out of hundreds of "move-in ready" apartments which would have required us to leave doors and windows open for two weeks. The alternative is a very expensive testing regimen which must continue for five years after completion of the building. All air handlers delivering outside air to the public spaces will be equipped with UV filtration as well as MERV filters. Water entering the building will be filtered down to 10 microns and each apartment sink has a separate filtered cold water spigot that filters it down to 1/2 micron.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Energy Star Equipment

LEED certification precedent has held that the innovation credit is awarded for use of Energy Star rated appliances when the energy cost savings are at least 5% of the total building energy cost. This may be hard to achieve in a building of this size. In any case, The Helena will feature Energy Star rated appliances in all apartment kitchens and in the public laundry rooms on each floor.

Energy Conservation

In addition to utilizing highly efficient equipment for all of the building's electro-mechanical needs, the Helena will have a "master switch" installed in each of the apartment units. This switch will allow residents to control all the overhead lighting and switched outlets and "set back" the heat pump's thermostat when they leave the apartment.

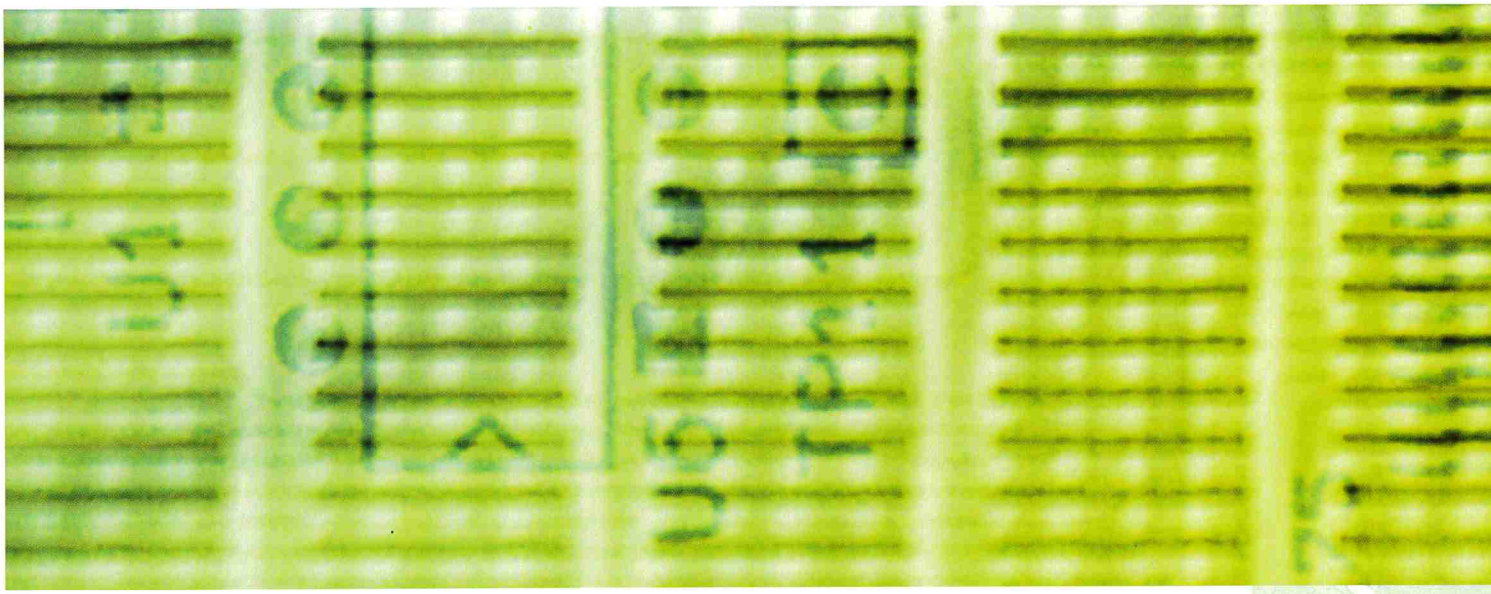
The corridors, stairwells and service area's lighting will be controlled by occupancy sensors, while the heat normally lost through bathroom and kitchen exhausts will be recovered and reutilized.

Lessons Learned

This case study is a snapshot in time. The Helena is still under construction and we have not yet applied for our LEED certification. Although some things may change, our Lessons Learned can help others better understand and navigate the process of implementing and documenting LEED in a multi-unit residential high rise. For complete details on the above mentioned LEED credit interpretation rulings, it would be advisable to access the USGBC's website (www.usgbc.org) for the full text.

Craig Wasoff, *a graduate engineer from Northeastern University, has close to 30 years of experience in the construction industry. For the past 12 years he has been with Rose Associates, Inc., serving as their Chief Engineer since 1995, responsible for all of their New York based construction activities.*

Pamela Lippe *is Executive Director of Earth Day New York and President of e4, inc. She is an innovative public affairs professional with almost thirty years experience in the environmental and communications fields. She is a strategic thinker and problem solver with broad creative, communication and organizing skills. Ms. Lippe has worked with a number of developers in the New York City area including the Port Authority of New York and New Jersey, Vornado Realty Trust, Mack-Cali Realty and most extensively, The Durst Organization. She was the environmental consultant on the 1.6 million sf Condé Nast Building at 4 Times Square – the first "green" skyscraper in the United States. She is currently working for The Durst Organization on over four million sf of new construction including two high rise residential buildings and a 2.1 million sf commercial office tower in midtown Manhattan.*



GREENING AFFORDABLE HOUSING AT THE 1400 FIFTH CONDOMINIUM

Carlton Brown,
Full Spectrum of NY, LLC

1400 Fifth Condominium, located at the intersection of 116th Street and 5th Avenue, is an affordable green condominium developed in south central Harlem on a former brownfield immediately adjacent to more than 5,000 units of public housing. For Full Spectrum, the "greening" of affordable housing starts with a point of view.

The fundamental need for sustainable housing could not be clearer. Whether the market, i.e., buyers, are aware of the benefits of green housing or whether they are even aware of the conceptual construct of "green housing," there is poignant empirical evidence of an overwhelming need in the marketplace. Medical studies have determined that 25% of Harlem's children have autoimmune diseases like asthma, for which indoor air quality is cited as a major causative factor in attacks that lead to hospitalization.

According to West Harlem Environmental Action (WEACT), African Americans in Harlem spend 25% more of their disposable income on energy than non-minority populations of New York. Both indoor air quality and energy consumption are environmental performance issues that green design can alleviate. People who live in affordable housing have the same need for quality space and amenities as people who live in market rate housing. When it comes to issues of environmental performance, i.e., health, energy and connectivity across the digital divide, the people who live in affordable housing have more deficiencies than those who live in market rate housing. The technological means for resolving many of these problems are in fact available and affordable in the market place. The difficulty is to use them in the face of tradition.

Full Spectrum's challenge, after deciding it was worth the risk, was to develop a strategy for designing and building an affordable green multi-family residence. There was neither a methodology nor a road map for achieving our goals. With few exceptions, the real estate sector in New York City believes that green development is too expensive for the general residential market and completely out of the question for the affordable housing market. As "contrarians" in the market, Full Spectrum sees things differently and believes that the primary obstacles to green affordable development are neither technological, regulatory nor financial.

We believe that a reliance on traditional methodologies of design and construction to mitigate inherent risk is the most formidable obstacle to green affordable development. By and large, the production chain of affordable housing developers is characterized by second and third generation developers who, in the 21st century, still rely on approaches that are driven by late 19th and 20th century technological and financial constraints. The route "out-of-the-box" requires nothing more than rethinking the decisions we are making out of habit, being open to alternative solutions and having the conviction to carry them through the project. In many cases, the constraints that first defined traditional solutions are no longer valid in the 21st century market place, and as a consequence, there is wide world of possibility.

Photo: Slide Carousel, courtesy of Full Spectrum, LLC

1400 Fifth Condominium is not a definitive road map, but a demonstration of one of many methodologies for developing affordable green housing in emerging urban markets. Each project is unique and ultimately must find its own way. Nevertheless, 1400 Fifth was successful in meeting both its environmental and economic objectives and is therefore a useful model to review. 1400 Fifth Condominium achieved LEED Silver; it qualified for the NYS Green Building Tax Credit; it was cited as the Energy Project of the Year by AEE (Association of Energy Engineers); and it was named as one of the top three intelligent buildings in the world by the Intelligent Buildings Forum, a global organization.

From an economic performance perspective, the building generated a waiting list of more than 5,000 applicants for 128 condominium units. The project created value in a submarket in which most financial institutions doubted a condominium development would perform. For those units that were sold without price restrictions, the sale price delivered a premium of more than $100/sf above other unrestricted projects in Harlem. Of the 128 condominium units in the development, 79 (61%) were sold to families with household incomes between $45,000 and $70,000 annually. Five percent were sold to families with household incomes between $70,000 and $85,000 and the balance 33% were sold at market rate with no household income restrictions. The 225,000 sf project, built with union labor, cost $135/sf, which was about three to five dollars more per sf than other "non-green" affordable housing being built in the Harlem market during the same period. From the developer's perspective, these achievements were indicative of a successful project.

How We Got There

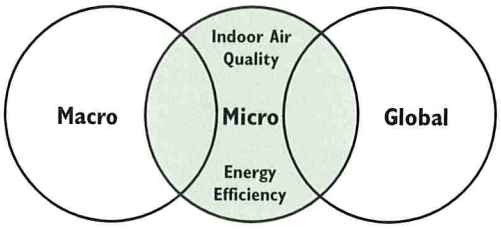
Quite simply, Full Spectrum got there through a good design process and good design. As most developers with experience in green development will attest, success starts with a commitment to an open iterative design process. Though the process took longer than the standard linear approach in which the standards from previous projects are quickly applied to the new project, the design team at 1400 was required to review and test every design decision against cost and performance using computerized performance models. The design team, in addition to the standard team members associated with affordable multi-family residential development, included a sustainable design/green building consultant, Steven Winter Associates; a hydro geologist, SSEC; a geothermal energy consultant, Water & Energy Inc; and a commissioning agent, Aramark.

This enhanced design team and extended design phase increased the cost of the design by about 30%, but more than 50% of the differential was offset by grants from NYSERDA. The NYSERDA Public Opportunity Notice (PON) application was daunting but the experience of Steven Winter Associates was an invaluable asset. Through various NYSERDA PON's, the 1400 Fifth Condominium project received approximately $600,000 in grants.

The US Green Building Council LEED guidelines were used as a navigation reference point for keeping the project on course, while the New York State Green Building Tax Credit (GBTC) guidelines were an absolute compass for directing the project design decisions. Because low and moderate income households have more limited financial resources, the economic value of the tax credits was a more important element in the value proposition for 1400 than it would have been for a market rate project in a mature market. The project received $1.7 million in tax credits which ultimately lowered the cost of home ownership by an average of $13,000 per household.

For low and moderate income households, this significantly reduced the cost of home ownership, thereby making the homes affordable to lower income brackets or freeing up disposable income for things other than housing. Though the residents of 1400 will benefit from this tax break, the affordable housing lobby has, for the most part, failed to advocate for extension

and expansion of the tax credit with the NYS Legislature and the Governor. Very few companies in the supply chain have recognized the value, the impact, or their ability to meet the required performance standards. Most mistakenly believe that the tax credit is applicable only to the most expensive top of the market and has no bearing on the affordable housing sector. Beyond the environmental performance criteria, other intelligent building performance targets outside of the purview of LEED and GBTC were established by the developer to address digital divide contradictions of the Harlem sub-market.



Early on in the process, Full Spectrum established a hierarchal order for targeting specific LEED, GBTC and smart building performance criteria for the project. Full Spectrum believes that there are three spheres of environmental impacts a development project may have: Micro, Macro and Global. The micro-environment impacts affect the people who will live or work in the building. The macro-environment impacts affect the "community" in which the development is sited, while the global environmental impacts affect the world.

Full Spectrum decided that the micro-environment was the area where we would be willing to commit resources greater than the norm for affordable housing development. The two most important performance criteria were Indoor Air Quality (IAQ) and Energy Efficiency (EE), both within the micro-environmental sphere of influence.

Among the more surprising findings, the development team discovered that in reaching the energy and indoor air quality performance objectives, they also achieved many objectives in the macro and global spheres of influence. Through a system of value engineering trade-offs for performance versus cost, we were able to create savings of $3.1 million dollars that were re-invested into the project. This re-investment allowed us to achieve broader environmental performance objectives and create more "creature comfort" curb appeal for buyers. Full Spectrum believes that the combination of green features and creature comfort were the value propositions for the 1400 Fifth Condominium development.

What Were the Principal Strategies?

Full Spectrum deployed several strategies to reach its green building objectives. For the micro-environmental sphere, first the team focused on passive means of improving building envelope performance. Next, it focused on mechanical system efficiency and finally, on indoor air quality. Table 1 illustrates a few of the deployed strategies and the impacts.

Beyond the strategies listed in Table 1, many other green building systems and materials were deployed. They included: digital sub-metered electric; bamboo

TABLE 1

STRATEGY	IMPACTS	HOW
Deployed panelized wall system with exterior insulation and brick tile on light gauge steel frame and gypsum.	Micro, Macro, Global	Improved thermal efficiency of the wall while reducing the cost vs. a laid up block and brick cavity wall of standard performance typically used on affordable housing. Reduced on site waste and contributed to resource efficiency. The steel was manufactured from 70% recycled sources; the gypsum was manufactured from 100% post industrial and recycled materials and the brick tile required less energy in its manufacturer than the masonry units in a traditional laid up block and brick cavity wall.
Utilized combination of structural steel, light gauge steel and slag concrete in a composite superstructure.	Global, Macro, Micro	The structural system was lighter than the standard pre-cast plank and bearing wall construction typically used in the multi-family affordable housing market. This eliminated the need for piles and created savings that could be used to cover the cost of green measures that exceeded the normative cost of affordable housing. The steel was manufactured from 70% recycled materials and was erected quicker, requiring less crane time and therefore reducing the negative impact on neighborhood air quality during construction. The slag concrete reduced the need for mined aggregate and produced a stronger structure.

STRATEGY	IMPACTS	HOW
Deployed a 400 ton geothermal heating and cooling system.	Micro, Macro, Global	The system uses no fossil fuels and, according to the DOE, is the most energy efficient system for heating and cooling residential buildings. Combined with other energy efficiency measures, the system is a major factor in reducing the buildings' energy consumption to 37% below the NYS energy code and about 70% below most other affordable housing projects built in Harlem. Because it uses no fossil fuels, it contributes to improved neighborhood air quality and improves the global environment. The system also incorporates digital set back thermostatic controls so that each resident can manage their own energy consumption and comfort. NYC DEP also has credited the geothermal system for reducing the buildings' water consumption and complying with the guidelines for reduced rate water billing.
Used high performance commercial grade thermal windows with low e glazing instead of residential grade windows.	Micro, Macro	Contributed to energy efficiency of the building. Because the window frames were made from 100% recycled aluminum, it reduced the impact on global resources.
Provided fresh air through mechanical means to each apartment instead of relying on infiltration through windows, walls and doors as the NYC Building Code permits.	Micro	Because the wall system allowed practically no air infiltration, fresh air had to be delivered to each apartment mechanically. The air is filtered twice through high efficiency filter systems conditioned and delivered to the apartment. This maintains lower carbon dioxide levels, minimizes or eliminates allergens from the air and improves indoor air quality while improving comfort levels of residents.
Used all low or no VOC adhesives, sealers, caulks, paints, etc.	Micro	The selection of materials that do not off gas will contribute to the long term health of the residents. The products for reaching this objective were premium priced when the project was specified but were normalized by market demand by the time the project was constructed.
Used condensing hot water heaters with gray water heat recovery for reducing energy consumption associated with providing potable hot water.	Micro, Macro	The system significantly reduces energy consumption and reduces the use of fossil fuel. By recovering heat from the waste water system, the hot water heating system efficiency is increased above what a normal high efficiency condensing hot water heater can provide. The system works in the 90% efficiency range.

floors; carpet from recycled materials; Energy Star Appliances and lighting fixtures; open grid pervious paving parking; high albedo roofing; gigabyte broadband network in each apartment with building wide intranet and business center with video conferencing, distance learning and entertainment facilities; native planting in landscaped areas; and well water for outdoor maintenance and landscape maintenance.

The Final Numbers

Full Spectrum believes the final numbers are an impressive testament to the possibility for wider scale development of green affordable housing. All differentials in first cost associated with the green development can be recovered in less than six years of reduced operating expenses. Each resident at 1400 Fifth will spend $1,000 less on energy than competing affordable housing developments will spend. The building will reduce energy consumption by 36%; reduce CO_2 production by 31%; reduce construction waste stream by 95%; reduce water consumption; improve indoor air quality; bridge the digital divide; and provide a greater level of human comfort and empowerment.

By selling 33% of the condominiums at market rate, the developer recovered far more than the differential cost of the green development. After NYSERDA grants are deducted, the differential cost is about $400,000. Though the cash on cost return, based on increased sales prices, is well over 1000%, it is difficult to assess how much of the premium differential in sales price vs. other projects in the market stems from market demand for the green features or for market demand for the creature comforts. Though Full Spectrum plans to conduct a post-occupancy survey to determine what has driven the market premiums, ideally it will be an impossible task. If in fact the project is an example of the seamless integration of affordable green housing, and quality affordable housing in which the market absorbs the differential cost increases while enhancing developer return, the developer is hopeful that it will encourage others to take the leap toward change.

Design Consulting Team

Roberta Washington	Lead Architect
William Q. Brothers	Architect
Trevor Salmon Associates	Structural Engineer
P. A. Collins, PC	Mechanical Electrical Engineer
EKLA	Landscape Architect
Steven Winter Associates	Environmental Consultant
Water & Energy Inc.	Geothermal Consultant
SSEC, Inc	Hydro-geologist
Ava Shypula	Building Envelope Consultant

Carlton Brown, *a founding partner and Chief Operating Officer of Full Spectrum, is a 1973 graduate of Princeton University's School of Architecture and Urban Planning. He has also studied real estate finance at New York University. He is responsible for the development and deployment of sustainable building technologies and strategies in Full Spectrum's developments and assuring that all projects have met appropriate performance and quality standards. Mr. Brown has been responsible for establishing Full Spectrum as one of the national leaders in the development of affordable green/smart buildings for emerging urban markets. Full Spectrum's 1400 on 5th Project was the only affordable housing project to qualify for the NYS Green Building Tax Credit and has been listed for LEED Silver. Carlton has served on several boards including the NY Chapter, AIA; the Business Resource & Investment Service Center (BRISC) of the Upper Manhattan Empowerment Zone; BEN Asset Group; and is the current board chair of 651 Arts. Mr. Brown has received numerous commendations from various organizations for his leadership and civic engagement including the New York City Partnership and Chamber of Commerce. Mr. Brown has served on the NYC High Performance Building Task Force and the NYC Brownfields Task Force and believes fundamentally, there is no conflict between environmental stewardship and real estate development.*

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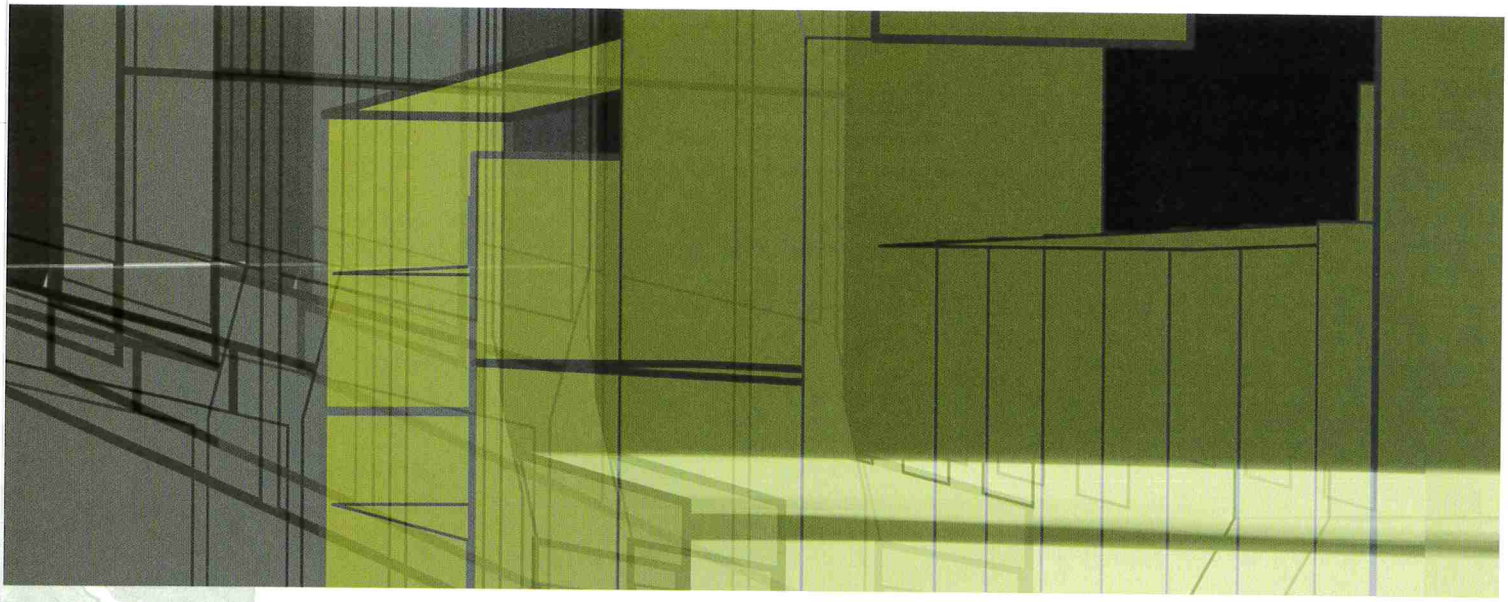


FROM GREEN BUILDINGS TO GREEN NEIGHBORHOODS: BETTER HEALTH, LIVABILITY AND BOTTOM LINE

Bert Gregory, AIA
Mithūn

"Sustainability... can be expressed in the simple terms of an economic golden rule for the restorative economy: leave the world better than you found it, take no more than you need, try not to harm the life of the environment, make amends if you do."

Paul Hawken, *The Ecology of Commerce*

Imagine a town full of high-performing buildings, all functioning efficiently and independently. Each owner has determined how best to make an economically viable and environmentally sensitive project. Each building has an eclectic group of strategies, which, put together, achieve the project's goals.

Now take a further leap of imagination, and envision the benefits of an entirely green neighborhood. It's off the grid, with no power lines. Rainwater is captured in downspouts which have been enlarged to provide storage. The remaining rainwater is directed to planted swales along the street and storage under the paving – staying in the neighborhood as it did when the land was once forested. Bikes, walkways and transit dominate the streetscape. Large trees provide over 30 percent canopy cover, and vegetative screens are integrated with the facades of buildings, reducing temperatures in the city by eight degrees. To top it all off, building owners have consolidated open space requirements and created a park, linking human and bird habitat to an off-site greenway system.

Sound like a picture of the distant future? Think again.

Europe leads the way

Europe already has many compelling examples of ecological infrastructure retrofitting. Neighborhood-scale projects in Freiburg, Lubeck and Liepzig, Germany have been successful with many aspects of sustainable design. The projects feature co-generation of heating and cooling shared between building types, biogas production providing electricity, and selling excess biogas and compost to contribute to the financial success of the project. In one project, homebuyers pay more for their home because they receive a monthly check for the energy produced beyond their consumption.

Americans pushing for green neighborhoods

Developers in the United States are currently searching for sources of energy and water with reliable costs. At the same time, people continue to demand healthy air and water quality and enhanced livability in their cities. Put together, these two forces produce opportunities for private-public partnerships, which begin to make a regenerative scenario a reality.

The Robert Wood Johnson Foundation has studied the link between public health and community design. They found that 35 percent of the skyrocketing health care costs in this country are attributable to people being overweight. The impacts are even higher than from smoking and drinking. Hypertension is more likely in U.S. counties characterized by urban sprawl, even

after adjusting for age, education, gender and other demographic factors. The study shows that a critical mass of compact development with a mix of uses that promotes walking can offset that trend. For example, housing and job access is generally three times as dense in Europe as it is in the U.S. As a result 66 percent of Europeans walk and ride bikes daily compared to a mere six percent in the U.S.

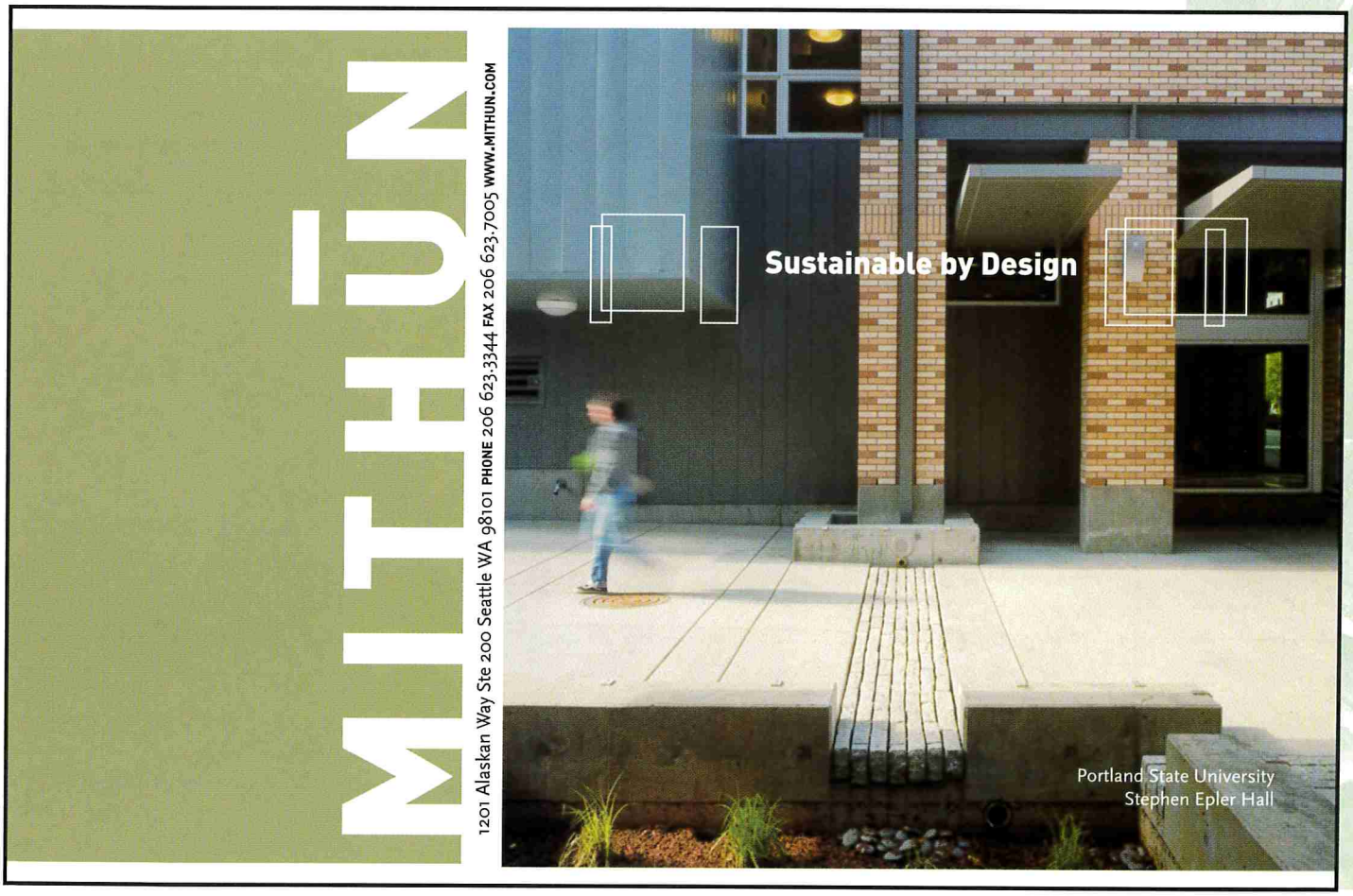
Another factor pushing sustainable design is the fact that water and energy prices are becoming more unpredictable each year. Water crises are increasingly common; and although water continues to be undervalued in price, it is becoming a commodity and under privatized control in many cities across the U.S. Blackouts are more frequent and reliance on power more interwoven with business profitability and communications than ever before. Consequently, independent water and energy sources increase predictability for the developer, property owner and tenants.

Over 78 percent of the people in the U.S. consider themselves environmentalists. Their concerns rest largely with the quality of the water they drink and the air that they breathe. Consumer awareness is growing regarding the benefits of green building and green neighborhoods, and market preferences are following suit when people are purchasing homes, locating businesses and seeking to lower investment risks.

Another indicator of market interest in green neighborhoods is the success of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) rating tool. Currently, the rating tool applies to individual commercial buildings. But demand has surfaced for a system to rate whole neighborhoods, new communities, campuses and military reservations. The success of the USGBC program rests largely on its ability to work across public, private and non-profit interests to build consensus around complex issues. Therefore, it can provide an excellent model for how to approach broader systems as it is developed over the next year or two.

What's different about a sustainable neighborhood plan?

The roads of a new neighborhood follow the contours of the land, there's a tree preservation area, and stormwater is handled in swales. What could be more environmentally sensitive than that? Actually, a lot... In order to create measurable value for the property, a sustainable neighborhood plan establishes Predevelopment Metrics, a baseline for measuring improvements to standard systems. Decision-making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Portland State University
Stephen Epler Hall

considers a triple bottom line – assessing economic, environmental and community benefits. This information can be valuable to developers for:

- Streamlining the approval process by demonstrating to jurisdictions lower infrastructure & resource demand
- Negotiating reductions in impact fees
- Improving the financing prospects of a project by demonstrating predictable utility costs
- Expanding the market niche of a project

Predevelopment Metrics

Predevelopment Metrics are comprised of environmental performance characteristics of the site in its natural or pre-development state. They measure how well a project "lives" within the natural-systems envelope of a site or community.

Predevelopment Metrics go beyond a typical site analysis to include water, habitat, energy, placemaking and materials. Specifically, water considers the site's annual rainfall budget. Habitat addresses the percentage of tree cover, species diversity and plant community characteristics. Energy measures the total incident solar budget and amounts reflected and used for photosynthesis by tree cover, carbon dioxide used, oxygen released and carbon fixed, and the electricity, natural gas and sources that generate power. Placemaking notes the street level and higher level land uses, streetscape character, building setbacks, solar massing potential, FAR transfer mechanisms and indexing the level of urban vibrancy. Materials analysis includes the usage of building material with a preference for low-embodied CO_2 contributing to carbon-neutral goals.

Community Design Sustainable Strategies

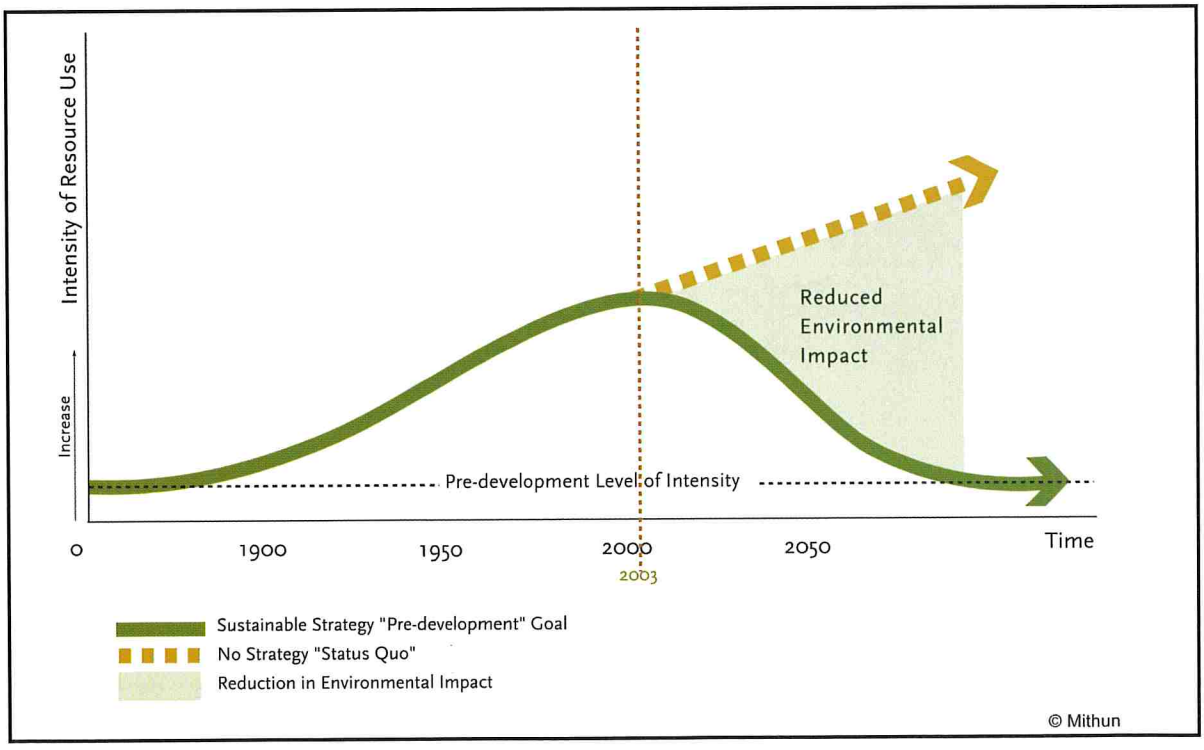
Sustainable community design mimics the natural systems of the predevelopment conditions as closely or as innovatively as possible. This requires a comprehensive look beyond site boundaries to understand how the natural systems function and are interdependent.

Water strategies include aggregated systems between public and private properties to make rainwater and reclaimed water economical in a market economy, on-site water recharging decentralized systems that handle rainwater close to where it falls, wastewater treatment and re-use.

Another innovative concept is to enhance habitat connectivity with wildlife corridors linking to off-site open space. When habitat areas are connected, species diversity is increased. This occurs because natural predator and prey relationships are supported, and adapted species such as starlings, raven pigeons, seagulls, squirrels, rats and feral cats are reduced. Rooftop gardens, vegetated roofs, increased tree canopy and understory planting further contribute to avian and insect habitat.

Energy strategies can optimize solar and wind orientation during neighborhood planning. Additional solutions include energy transfer technology to share heating and cooling between building types, and the renewable energy mix of photovoltaics, wind turbine, biogas generation from district waste processing and purchasing of renewable energy sources.

It's important to address sustainable building material usage as well. The resource-intensive construction



industry consumes 40 percent of all raw materials in the global community. The environmental impacts of extraction, manufacturing and fabrication, transportation, installation, maintenance and disposal of construction materials are major contributors to greenhouse gas emission, toxic emissions, habitat destruction and resource depletion.

Materials in a sustainable community development should be selected based on long-term energy efficiency and low-embodied CO_2 content, in order to contribute to carbon-neutral conditions. Durability, low-maintenance and local materials reduce transportation impacts. Buildings should use fewer materials; use materials that contribute to better indoor-air quality; and include renewable resources. In addition, building components that can be upgraded (rather than replaced) for superior energy performance provide a better return on investment. Savvy product vendors and manufacturers have begun to make this information available, and many have developed a market niche by responding to sustainability issues raised by consultants and contractors.

Financial Benefits

Numerous financial benefits come from creating sustainable neighborhoods, such as:

- Offsetting municipal charges;
- Streamlining permitting and public approval process;
- Reduction of ongoing energy, water, sewer and maintenance costs;
- Increasing predictability of those utility costs;
- Reducing capital costs with smaller roads, less grading, fewer pipes; and
- Reducing infrastructure demand at the municipal level which creates capacity for future growth.

Community Benefits

Some municipalities have started rewarding developments that reduce their impact on public infrastructure, since they permit additional capacity at no extra public investment. This reflects municipalities' understanding that the entire community benefits from sustainable neighborhoods through:

- Reduction in demand for public wastewater treatment systems
- Reduction in demand for public potable water systems
- Use of reclaimed water for irrigation in public right-of-way
- Reduction in demand for energy generated from non-renewable sources (coal and gas-fired power plants)
- Support for renewable energy sources (wind power purchases)
- Increased utilization of local energy generation systems (photovoltaic, wind, biogas)
- More efficient utilization of energy through neigh-

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borhood waste heat recovery systems (thermal loop systems) integrated with building level efficiency
- Environmentally efficient neighborhood development that can be used as a model for other areas
- Improved public infrastructure (open space, green streets, intersection upgrades)
- Improved solar access in public right-of-way
- Efficient utilization of available Floor Area Ratio (lessens development pressure on outlying areas)
- Active, vibrant urban neighborhood supporting a diverse range of jobs

Case Studies

Sustainable neighborhood scenarios in the United States are being tested with strategies for individual buildings and project-specific redevelopment in a wide range of locations – rural, suburban and urban. The Lloyd Crossing Sustainable Urban Design Plan for an urban neighborhood in downtown Portland is a comprehensive public/private model for redevelopment. It's easy to imagine how the Predevelopment Metric strategy explored in this project and described above can apply across a range of scales and project types.

Suburban – Time is Right for the Idea Home

- Homebuyers are now ready to pay premiums for high performance standards in individual homes, and master planned community developers are beginning to brand their developments around green values. This is being demonstrated by Port Blakely Communities' Issaquah Highlands project in Washington, a large community which requires all home builders in their newest phase to build to a "Three Star" level. Built Green™ is a green building rating system for residential homes that can be easily and economically incorporated into any new home.
- To demonstrate practical, more aggressive green strategies for the homebuyer, the Master Builders

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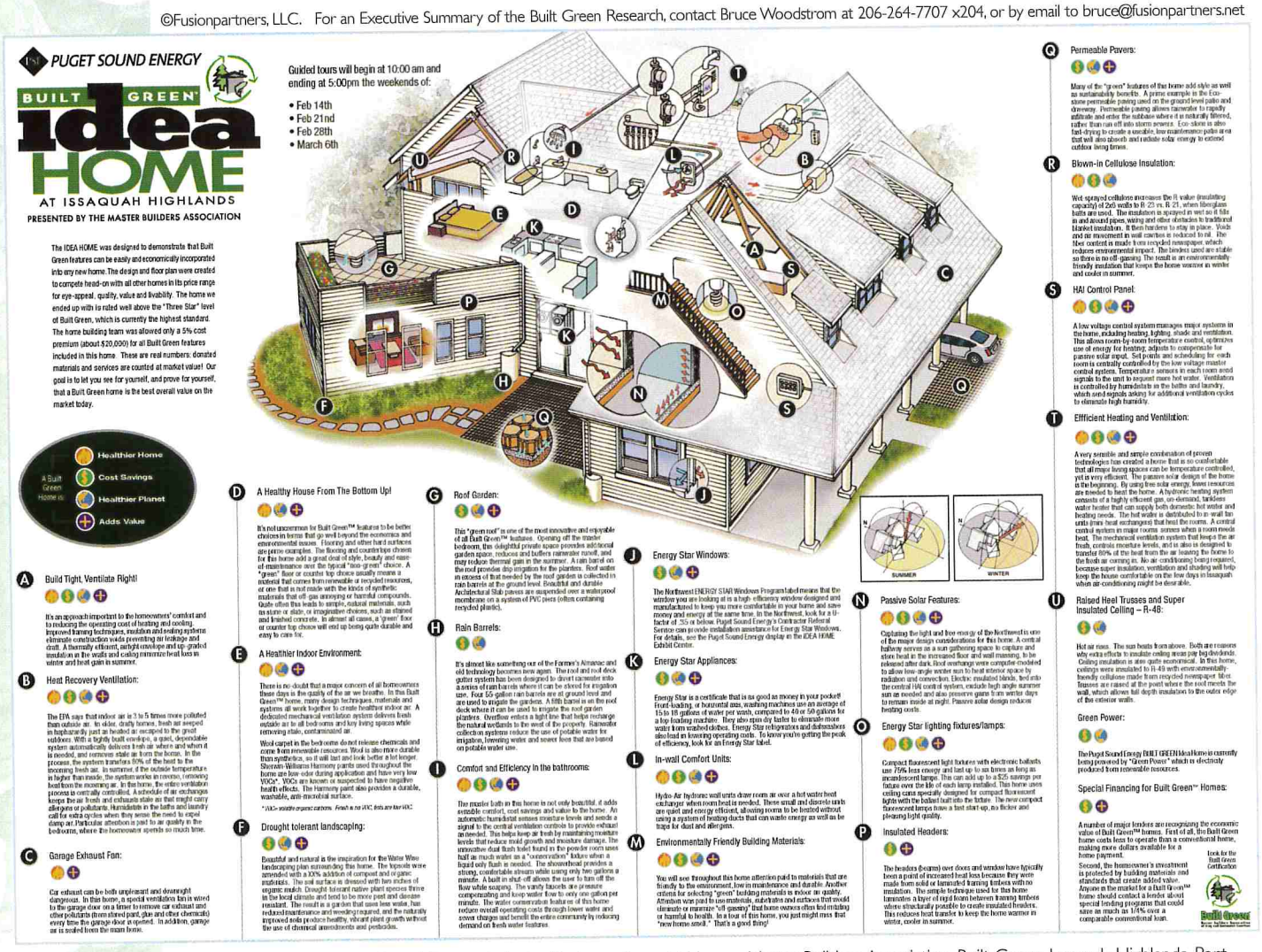

PUGET SOUND ENERGY
BUILT GREEN
idea HOME
AT ISSAQUAH HIGHLANDS
PRESENTED BY THE MASTER BUILDERS ASSOCIATION
Guided tours will begin at 10:00 am and ending at 5:00pm the weekends of:
• Feb 14th
• Feb 21nd
• Feb 28th
• March 6th
The IDEA HOME was designed to demonstrate that Built Green features can be easily and economically incorporated into any new home. The design and floor plan were created to compete head-on with all other homes in its price range for eye-appeal, quality, value and livability. The home we ended up with is rated well above the "Three Star" level of Built Green, which is currently the highest standard. The home building team was allowed only a 5% cost premium (about $20,000) for all Built Green features included in this home. These are real numbers: donated materials and services are counted at market value! Our goal is to let you see for yourself, and prove for yourself, that a Built Green home is the best overall value on the market today.
A Built Green Home is:
Healthier Home
Cost Savings
Healthier Planet
Adds Value
A Build Tight, Ventilate Right!
It's an approach important to the homeowners' comfort and to reducing the operating cost of heating and cooling. Improved framing techniques, insulation and sealing systems eliminate construction voids preventing air leakage and draft. A thermally efficient, airtight envelope and up-graded insulation in the walls and ceiling minimize heat loss in winter and heat gain in summer.
B Heat Recovery Ventilation:
The EPA says that indoor air is 3 to 5 times more polluted than outside air. In older, drafty homes, fresh air seeped in haphazardly just as heated air escaped to the great outdoors. With a tightly built envelope, a quiet, dependable system automatically delivers fresh air where and when it is needed, and removes stale air from the home. In the process, the system transfers 80% of the heat to the incoming fresh air. In summer, if the outside temperature is higher than inside, the system works in reverse, removing heat from the incoming air. In the home, the entire ventilation process is centrally controlled. A schedule of air exchanges keeps the air fresh and exhausts stale air that might carry allergens or pollutants. Humidistats in the baths and laundry call for extra cycles when they sense the need to expel damp air. Particular attention is paid to air quality in the bedrooms, where the homeowner spends so much time.
C Garage Exhaust Fan:
Car exhaust can be both unpleasant and downright dangerous. In this home, a special ventilation fan is wired to the garage door on a timer to remove car exhaust and other pollutants (from stored paint, glue and other chemicals) every time the garage door is opened. In addition, garage air is sealed from the main home.
D A Healthy House From The Bottom Up!
It's not uncommon for Built Green™ features to be better choices in terms that go well beyond the convenience and environmental issues. Flooring and other hard surfaces are prime examples. The flooring and countertop chosen for this home add a great deal of style, beauty and ease-of-maintenance over the typical "non-green" choice. A "green" floor or counter top choice usually means a material that comes from renewable or recycled resources, or one that is not made with the kinds of synthetic materials that off-gas annoying or harmful compounds. Quite often this leads to simple, natural materials, such as stone or slate, or imaginative choices, such as stained and linoleum concrete. In almost all cases, a "green" floor or counter top choice will end up being quite durable and easy to care for.
E A Healthier Indoor Environment:
There is no doubt that a major concern of all homeowners these days is the quality of the air we breathe. In this Built Green™ home, many design techniques, materials and systems all work together to create healthier indoor air. A dedicated mechanical ventilation system delivers fresh outside air to all bedrooms and key living spaces while removing stale, contaminated air.
Wool carpet in the bedrooms do not release chemicals and come from renewable resources. Wool is also more durable than synthetics, as it will last and look better a lot longer. Sherwin-Williams Harmony paints used throughout the home are low-odor during application and have very low VOCs*. VOCs are known or suspected to have negative health effects. The Harmony paint also provides a durable, washable, anti-microbial surface.
* VOCs- volatile organic solvents. Terms in red VOC lists are low VOC
F Drought tolerant landscaping:
Beautiful and natural is the inspiration for the Water Wise landscaping plan surrounding the home. The topsoils were amended with a 30% addition of compost and organic materials. The soil surface is dressed with two inches of organic mulch. Drought tolerant native plant species thrive in the local climate and tend to be more pest and disease resistant. The result is a garden that uses less water, has reduced maintenance and weeding required, and the naturally improved soils produce healthy, vibrant plant growth without the use of chemical amendments and pesticides.
G Roof Garden:
This "green roof" is one of the most innovative and enjoyable of all Built Green™ features. Opening off the master bedroom, this delightful private space provides additional garden space, reduces and buffers rainwater runoff, and may reduce thermal gain in the summer. A rain barrel on the roof provides drip irrigation for the planters. Roof water in excess of that needed by the roof garden is collected in rain barrels at the ground level. Beautiful and durable Architectural Slab pavers are suspended over a waterproof membrane on a system of PVC piers (often containing recycled plastic).
H Rain Barrels:
It's almost like something out of the Farmer's Almanac and old technology becomes new again. The roof and roof deck gutter system has been designed to direct rainwater into a series of rain barrels where it can be stored for irrigation use. Four 55-gallon rain barrels are at ground level and are used to irrigate the gardens. A fifth barrel is on the roof deck where it can be used to irrigate the roof garden planters. Overflow enters a light line that helps recharge the natural wetlands to the west of the property. Rainwater collection systems reduce the use of potable water for irrigation, lowering water and sewer fees that are based on potable water use.
I Comfort and Efficiency In the bathrooms:
The master bath in this home is not only beautiful, it adds enviable comfort, cost savings and value to the home. An automatic humidistat senses moisture levels and sends a signal to the central ventilation controls to provide exhaust as needed. This helps keep air fresh by maintaining moisture levels that reduce mold growth and moisture damage. The innovative dual flush toilet found in the powder room uses half as much water as a "conventional" fixture when a frigid only flush is needed. The showerhead provides a strong, comfortable stream while using only two gallons a minute. A built in shut-off allows the user to turn off the flow while soaping. The vanity faucets are pressure compensating and keep water flow to only one gallon per minute. The water conservation feature of this home reduces overall operating costs through lower water and sewer charges and benefit the entire community by reducing demand on fresh water features.
J Energy Star Windows:
The Northwest ENERGY STAR Windows Program label means that the window you are looking at is a high efficiency window designed and manufactured to keep you more comfortable in your home and save money and energy at the same time. In the Northwest, look for a U-factor of .35 or below. Puget Sound Energy's Contractor Referral Service can provide installation assistance for Energy Star Windows. For details, see the Puget Sound Energy display in the IDEA HOME Exhibit Center.
K Energy Star Appliances:
Energy Star is a certificate that is as good as money in your pocket! Front-loading, or horizontal axis, washing machines use an average of 15 to 18 gallons of water per wash, compared to 40 or 50 gallons for a top loading machine. They also spin dry faster to eliminate more water from washed clothes. Energy Star refrigerators and dishwashers also lead in lowering operating costs. To know you're getting the peak of efficiency, look for an Energy Star label.
L In-wall Comfort Units:
Hydro-Air hydronic wall units draw room air over a hot water heat exchanger when room heat is needed. These small and discrete units are quiet and energy efficient, allowing rooms to be heated without using a system of heating ducts that can waste energy as well as be traps for dust and allergens.
M Environmentally Friendly Building Materials:
You will see throughout this home attention paid to materials that are friendly to the environment, low in maintenance and durable. Another criteria for selecting "green" building materials is indoor air quality. Attention was paid to use materials, substrates and surfaces that would eliminate or minimize "off-gassing" that some owners often find irritating or harmful to health. In a tour of this home, you just might miss that "new home smell." That's a good thing!
N Passive Solar Features:
Capturing the light and free energy of the Northwest is one of the major design considerations for this home. A central hallway serves as a sun gathering space to capture and store heat in the increased floor and wall massing, to be released after dark. Roof overhangs were computer-modeled to allow low-angle winter sun to heat interior space by radiation and convection. Electric insulated blinds, tied into the central HAI control system, exclude high angle summer sun as needed and also preserve warm from winter days to remain inside at night. Passive solar design reduces heating costs.
O Energy Star lighting fixtures/lamps:
Compact fluorescent light fixtures with electronic ballasts use 75% less energy and last up to six times as long as incandescent lamps. This can add up to a $25 savings per fixture over the life of each lamp installed. This home uses ceiling cans specially designed for compact fluorescent light with the ballast built into the fixture. The new compact fluorescent lamps have a fast start-up, no flicker and pleasing light quality.
P Insulated Headers:
The headers (beams) over doors and window have typically been a point of increased heat loss because they were made from solid or laminated framing timbers with no insulation. The simple technique used for this home laminates a layer of rigid foam between framing timbers where structurally possible to create insulated headers. This reduces heat transfer to keep the home warmer in winter, cooler in summer.
Q Permeable Pavers:
Many of the "green" features of the home add style as well as sustainability benefits. A prime example is the Eco-stone permeable paving used on the ground level patio and driveway. Permeable paving allows rainwater to rapidly infiltrate and enter the subbase where it is naturally filtered, rather than run off into storm sewers. Eco-stone is also fast-drying to create a useable, low maintenance patio area that will also absorb and radiate solar energy to extend outdoor living times.
R Blown-in Cellulose Insulation:
Wet sprayed cellulose increases the R value (insulating capacity) of 2x6 walls to R-23 vs. R-21, when fiberglass batts are used. The insulation is sprayed in wet so it fills in and around pipes, wiring and other obstacles to traditional blanket insulation. It then hardens to stay in place. Voids and air movement in wall cavities is reduced to nil. The fiber content is made from recycled newspaper, which reduces environmental impact. The binders used are stable so there is no off-gassing. The result is an environmentally friendly insulation that keeps the home warmer in winter and cooler in summer.
S HAI Control Panel:
A low voltage control system manages major systems in the home, including heating, lighting, shade and ventilation. This allows room-by-room temperature control, optimizes use of energy for heating, adjusts to compensate for passive solar input. Set points and scheduling for each room is centrally controlled by the low voltage master control system. Temperature sensors in each room send signals to the unit to request more hot water. Ventilation is controlled by humidistats in the baths and laundry, which send signals asking for additional ventilation cycles to eliminate high humidity.
T Efficient Heating and Ventilation:
A very sensible and simple combination of proven technologies has created a home that is as comfortable that all major living spaces can be temperature controlled, yet is very efficient. The passive solar design of the home is the beginning. By using free solar energy, fewer resources are needed to heat the home. A hydronic heating system consists of a highly efficient gas fire furnace, tankless water heater that can supply both domestic hot water and heating needs. The hot water is distributed to in-wall fan units (mini heat exchangers) that heat the rooms. A central control system in major rooms senses when a room needs heat. The mechanical ventilation system that keeps the air fresh, controls moisture levels, and is also is designed to transfer 80% of the heat from the air leaving the home to the fresh air coming in. No air conditioning being required, because super insulation, ventilation and shading will help keep the house comfortable on the few days in Issaquah when air conditioning might be desirable.
SUMMER
WINTER
U Raised Heel Trusses and Super Insulated Ceiling – R-48:
Hot air rises. The sun heats from above. Both are reasons why extra efforts to insulate ceiling areas pay big dividends. Ceiling insulation is also quite economical. In this home, ceilings were insulated to R-48 with environmentally-friendly cellulose made from recycled newspaper. Heel trusses are raised at the point where the roof meets the wall, which allows full depth insulation to the outer edge of the exterior walls.
Green Power:
The Puget Sound Energy BUILT GREEN Idea Home is currently being powered by "Green Power" which is electricity produced from renewable resources.
Special Financing for Built Green™ Homes:
A number of major lenders are recognizing the economic value of Built Green™ homes. First of all, the Built Green home costs less to operate than a conventional home, making more dollars available for a home payment.
Second, the homeowner's investment is protected by building materials and standards that create added value. Anyone in the market for a Built Green™ home should contact a lender about special lending programs that could save as much as 1/4% over a comparable conventional loan.
Look for the Built Green Certification
Built Green

Presenting Partner: Puget Sound Energy; Industry Partners: Bennett Homes, Master Builders Association, Built Green, Issaquah Highlands, Port Blakely Communities, Mithun; Community Partners: King County, City of Issaquah; Environmental Partners: Mutual Materials, Whirlpool, Windermere, Sherwin Williams, Countrywide Home Loans, FannieMae, Northwest Energy Efficiency Alliance; Media Partner: The Seattle Times; Marketing Partner: Fusion Partners LLC

Association, creators of Built Green, asked Mithun to develop a design to compete head on with all other homes in its price range for eye-appeal, quality, value and livability, while moving well above the "Three Star" level of Built Green, currently the highest standard. The home building team was allowed only a five percent cost premium for all Built Green features included in the home. Interest was high, and over 8,000 visitors took docent-guided tours of the Puget Sound Energy Built Green Idea Home over ten weekends. "The Idea Home was a pivotal success in gaining awareness for a practical approach to Built Green in the Puget Sound region," noted Judd Kirk, President of Port Blakely, "...a realistic demonstration of techniques to create a healthier home, a home that costs less to operate, uses materials and techniques that are friendly to the environment and results in a home with lasting value."

Large production home builders are paying attention to green trends. After all, it's good business sense to conserve materials. Builders also profit when buyers request deluxe energy packages, driven by a desire for lower utility bills.

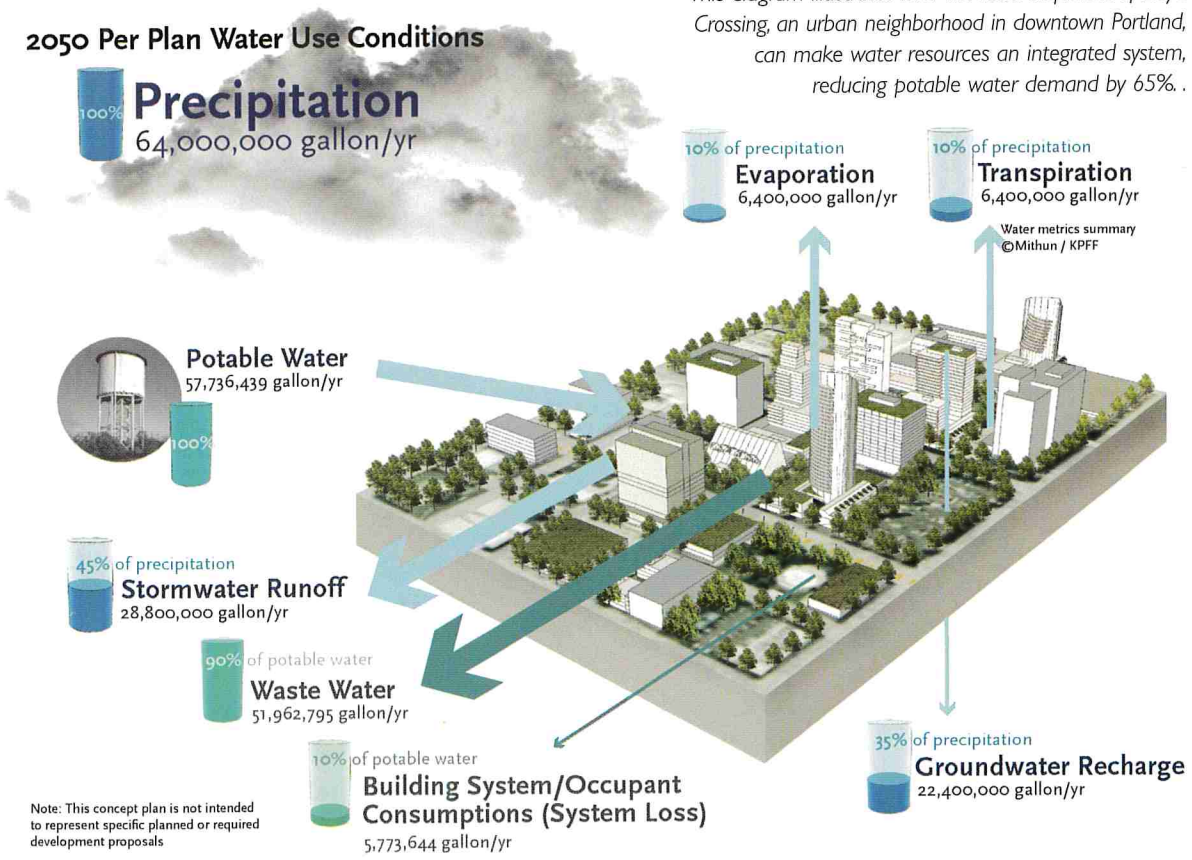
Low-Scale Urban:
Innovative water strategies

Two Northwest redevelopment projects – High Point in Seattle, Washington and New Columbia in Portland, Oregon – illustrate how creative water planning can contribute to ecological infrastructure improvements and lower operating costs.

At High Point, the 129-acre mixed use community will include 1,600 units of rental and market-rate housing. The neighborhood makes up one-tenth of the Longfellow Creek watershed, one of Seattle's priority watersheds with the highest Coho salmon return counts for Seattle creeks. Ecological systems therefore provided the basis of design. Streets and open spaces incorporate natural drainage strategies, recreation and placemaking. Four miles of vegetated bio-swales in the public right-of-way are integrated with parks. Similar projects monitored in the residential right-of-ways in Seattle have retained 98 percent of the water on site – an enormous load removed from the public infrastructure system.

New Columbia is set on 80 acres near downtown Portland in the Portsmouth neighborhood. Water conservation practices reduce both resident utility costs and the energy consumed to deliver and heat water. Water conservation cuts down the amount of water discharged from a building, lessening the likelihood of untreated discharges into the surrounding rivers and freeing up capacity in the city's combined stormwater and wastewater treatment facilities. All of the rainwater is handled on-site through a combina-

This diagram illustrates how the redevelopment of Lloyd Crossing, an urban neighborhood in downtown Portland, can make water resources an integrated system, reducing potable water demand by 65%. .



tion of decentralized strategies tucked throughout the neighborhood, contributing to multiple functions of habitat, recreation and reducing energy demand.

High-Rise Urban:
Portland's plan for a showcase

Portland is thinking big when it comes to green development. Its Lloyd Crossing Sustainable Urban Design Plan strives to create a unique, vibrant, attractive and healthy community that is also environmentally and financially sustainable. If successful, the new district would dramatically lower local and global impact for an urban neighborhood. The goal is to reach the environmental footprint of the original natural ecosystem found on the site within 45 years.

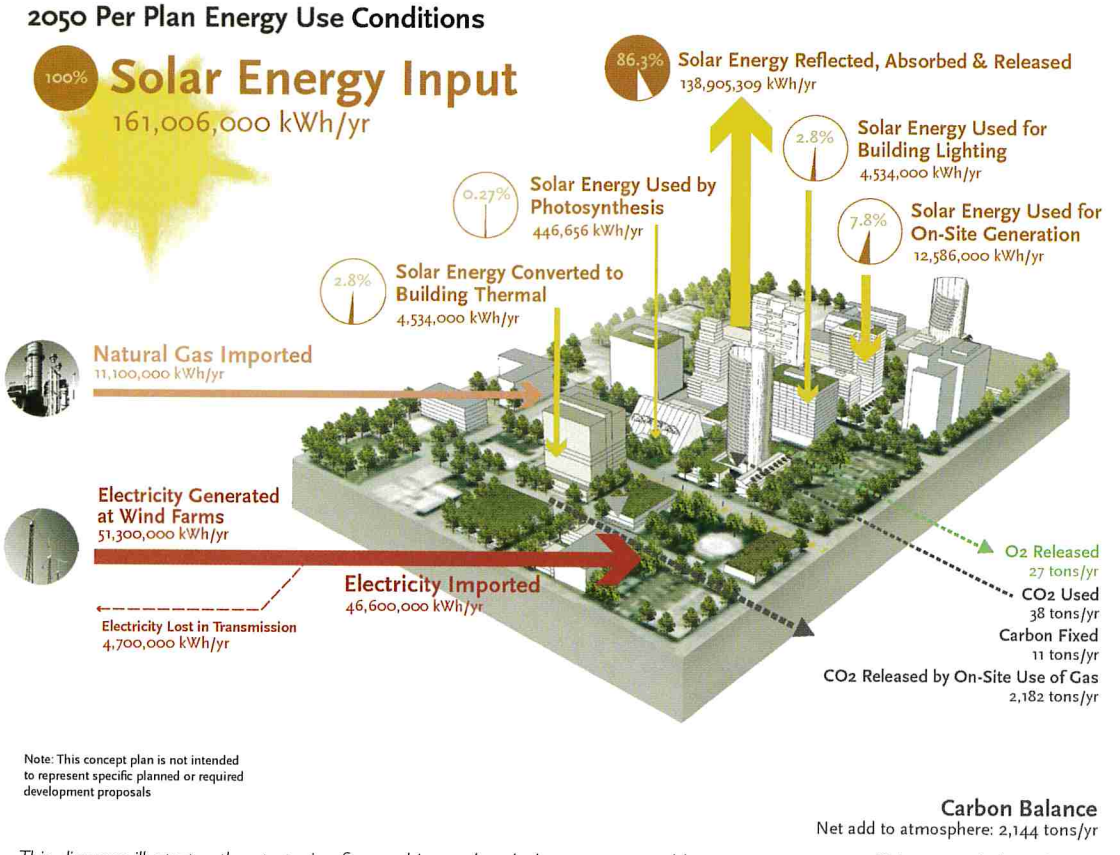
The 35-block Lloyd Crossing study area currently contains 2.8 million square feet of developed building area, a mix of office, retail, lodging, residential, restaurant and above-grade parking use. The current baseline Floor Area Ratio (FAR) allows 15.6 million square feet. Over the next 45 years, the study predicts that the market could absorb 8.1 million square feet more, 70 percent of the baseline FAR capacity. An increase in residential development is predicted as well, for a 1:1 ratio between residential and commercial use by the year 2050.

The Lloyd Crossing plan establishes Pre-development Metrics, assuming that the predevelopment site was much like a mature mixed-conifer forest. In its predevelopment condition, the 54-acre study area generated the following metrics:

Habitat and Tree Cover – To create a forest-like habitat, the plan proposes increasing tree cover and habitat areas in general. Dense urban areas would be linked with green spaces for a higher intensity of functioning native habitat. These measures would create habitat zones, reduce urban heat and provide corridors from open space to adjacent mixed-conifer forests.

Water – The plan envisions a near water-neutral area to minimize reliance on imported water and radically reduce demand for off-site wastewater treatment, while providing significant economic benefit to the neighborhood. For potable water, the neighborhood would use rain that normally falls on the site. All stormwater and wastewater streams would be treated on-site prior to being recycled, infiltrated, or discharged, replicating predevelopment conditions as closely as possible.

Energy – Incremental energy efficiency strategies would contribute to a natural carbon balance at Lloyd Crossing by the year 2050. These strategies work together to reduce the neighborhood's reliance on non-renewable sources of power, increase its utilization of available



This diagram illustrates the strategies for reaching carbon balance – renewable energy resources, efficiency and shared energy.

solar energy, and generate cost savings for reinvestment in other areas. The result would be a neighborhood where carbon dioxide emissions closely match the pre-development condition, and solar energy utilization exceeds predevelopment conditions by a significant percentage.

Financing – How would Lloyd Crossing be implemented and funded? Through a combination of existing mechanisms and new concepts which together deliver the necessary money, management and messages. By encouraging the growth of strong public/private partnerships, utilizing savings from existing tax incentives and projected operating efficiencies, and by identifying potential new sources of capital, a funding framework could be created to repay the required investment.

A Resource Management Association (RMA) would manage the financial and physical implementation of sustainable strategies. Over the 45-year study period, $40 million could be raised by the RMA to help fund district-wide infrastructure improvements. A percentage of City System Development Charges could also be earmarked to help pay for Lloyd Crossing. These charges are currently imposed as impact fees for project approvals. Using a portion of these charges would make sense, particularly if Lloyd District was "off the grid" for some of the city's infrastructure services.

Focusing on the Future

What's next? Some future scenarios suggest that density may in some locations eventually be based on the carrying capacity of the land. Carrying capacity is the maximum amount of development that a place can sustain and maintain its own resources over time. As large scale infrastructure costs escalate to the point of being problematic, resources become more expensive and water avilability becomes an issue; creating more with less will be paramount for development in some areas to continue. Thinking of neighborhoods as urban ecosystems, combining resource management and placemaking can be a cost-effective path to vibrant, livable, environmentally smart new communities in the 21st Century.

BERT GREGORY, *AIA, is President & CEO of Mithūn, a 145 person Seattle firm. Bert's progressive, design-oriented architectural background has led to award-winning projects throughout North America and Asia. He is a recognized expert in resource efficient design, speaking nationally on sustainable building & sustainable urbanism. Bert possesses a diverse project background, which includes architectural projects such as IslandWood, the northwest's innovative outdoor learning center, to urban design plans such as "The Blue Ring," Seattle's ASLA National Honor Award winning City Center strategy, and Portland, Oregon's new zero carbon Lloyd Crossing Sustainable Urban Design Plan. He recently served as President for the Seattle Chapter American Institute of Architects. Bert's national impact in design leadership has been noted by the AIA, the IIDA, and CoreNet Global, which honored Mithun with the 2003 Sustainable Design Leadership Award. Mithūn has received three AIA COTE Top Ten United States Green Projects awards, all under Bert's design leadership.*

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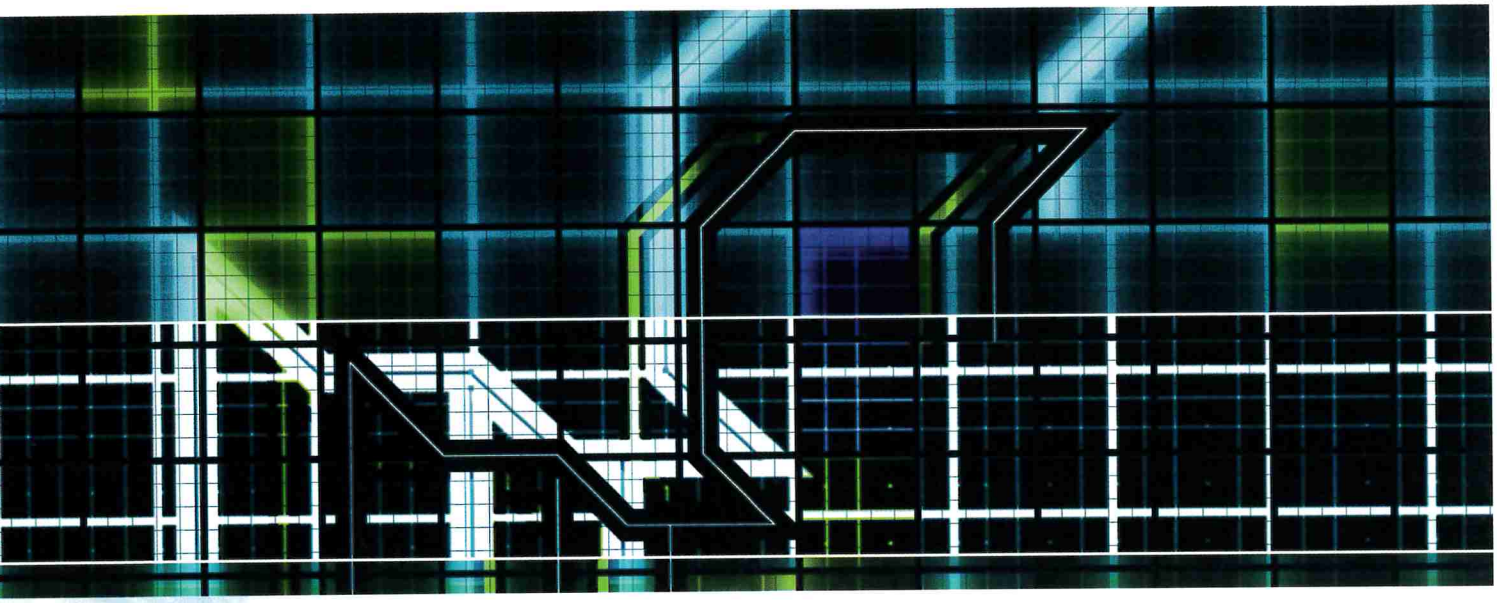


THERMAL STORAGE: DOLLARS AND SENSE

Eugene Garcia
ECM Energy Management Services
Todd Coulard
Trane, New York

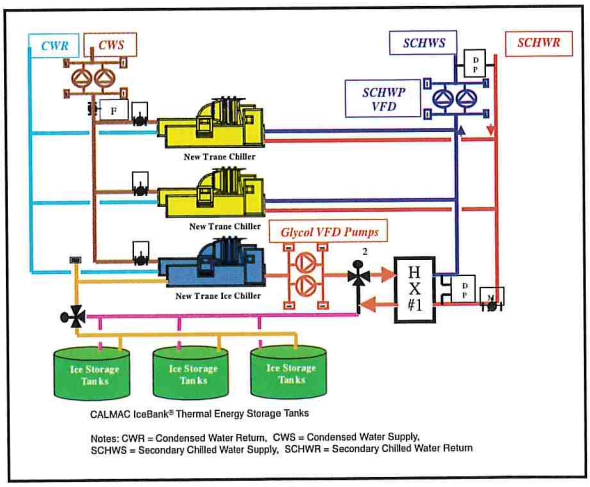
How would you like to find an investment that provides a simple payback in three to five years, requires no money down and is cash positive from Day One? Thermal storage is a technically and financially sound approach that often fits that model. Utilizing thermal storage and determining when it makes financial sense can be much easier if you understand the key variables that drive the economics.

Basic Thermal Storage Mechanics

Although there are other kinds of thermal storage systems (e.g., chilled water), our discussion will be limited to Ice Storage. Ice Storage technology makes the most sense because of space limitations in most commercial buildings. An ice storage system uses a chiller to make ice during off-peak night time hours when energy is cheaper, and then melts the ice for peak period cooling needs, effectively shifting the electric load and avoiding higher price energy and demand charges during the day. The operation of an Ice Storage System is comprised of two normal modes: the Ice Charging Mode and the Ice Melt/Burn Mode.

During the Ice Charging Mode, typically there is a designated ice making chiller that will be run for the purpose of producing low temperature glycol to freeze the water inside an ice storage tank. The glycol loop, consisting of the ice storage tanks, heat exchangers and glycol pumps, are isolated from the main building chilled water loop (See flow diagram below). The Ice Charging Mode continues until full ice capacity has been reached, usually lasting about eight to ten hours and corresponding with the utility's off-peak period.

Ice Melt Mode commences when the temperature differential between the chilled water supply and the chilled water return increases as the building load increases. The ice melt mode is initiated via an automated process or by system operators after they have received an advisory message. During this peak period, usually 10 to 14 hours during the weekdays, the water chiller operates in conjunction with the Glycol Loop. The Glycol Pumps starts, the mixing valve modulates under the control of a temperature sensor and the diverting valve controls flow through the Heat Exchangers. The mixing valve modulates to maintain a specified glycol supply water temperature to heat exchangers.



Sample flow diagram with Trane chillers and CALMAC IceBank® thermal storage tanks.

Economics
The economic feasibility of an Ice Storage System is dependent on many of the same variables that affect any type of cooling system infrastructure, including utility rates, load profile and capital costs.

Utility Rates – Reduced on-peak demand and the shift from on-peak consumption to off-peak consumption has significant advantages because of utility rates. The most significant component in this category is the peak demand charge. The higher the demand charge, the greater the impact on the savings. New York's Con Edison peak demand charges, typically in excess of $30/kW in the summer and $15-$20/kW in winter, make this utility territory an excellent candidate for ice storage (based on ConEd's SC-9 and SC-4 Rate II).

The differential between on-peak and off-peak energy rates ($/kWh) is the second part of the utility rate to impact the economics. Again, in ConEd's territory we see a significant spread in the two to three cent per kWh range. A facility purchasing third party electric commodity will see this variance between on-peak energy and off-peak energy as an overall discount in its quoted fixed price. Depending on the wholesale markets, the facilities' overall load profile and the amount of load shifting, this discount is typically a few tenths of a cent discount on the entire facility's electric purchase.

Rate structure, as opposed to the actual per kW or per kWh charge, can also have a significant impact on the economic outcome of a project. Two good examples are a tiered rate structure that lowers the per unit cost as the facility demand and consumption increases, or a ratcheted demand that penalizes a facility throughout the year for excessive demand in any given month.

Load Profile – (The varying electric demand and energy consumption pattern of a facility, more specifically, its air conditioning ["AC"] load profile).

Typically, those facilities with more significant spikes in their daily AC load profile make better candidates for ice storage. Reduced ton-hour requirements resulting from a shorter period of peak demand translates into less capital per kW of desired demand reduction.

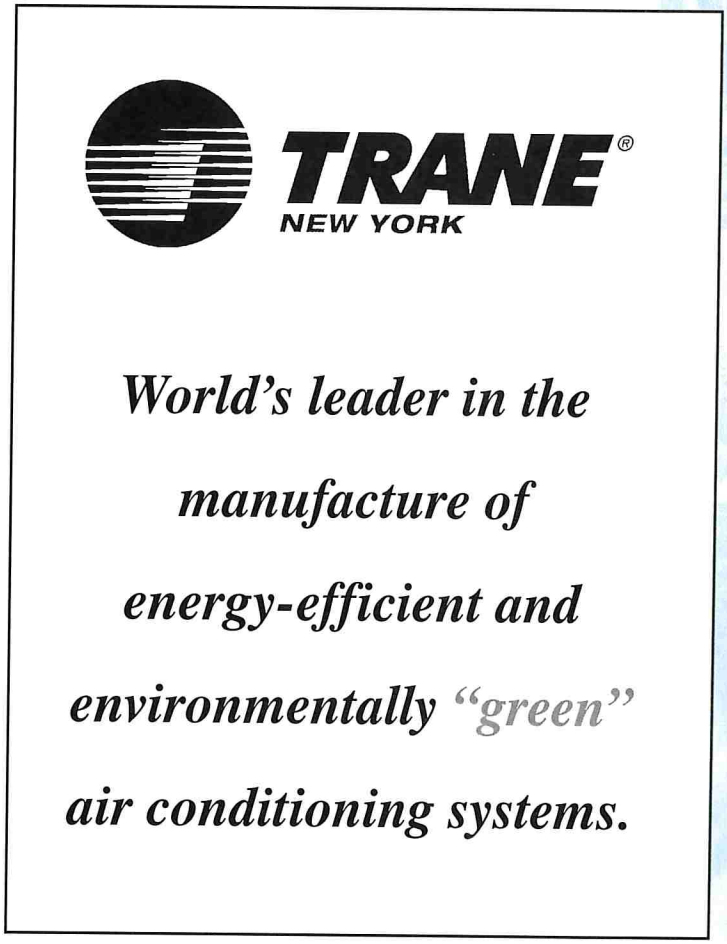
The number of months requiring mechanical cooling (chillers) has a significant impact. Increased asset utilization, like most financial evaluations, results in a greater return. Having the ability to use an ice storage system throughout the year, as opposed to a five or six month cooling season, increases the savings dramatically. Extended cooling seasons are a function of geography and facility use.

Existing electric chiller efficiency, although not directly driving the load profile, does affect the magnitude of the electric demand per ton of refrigeration. The relationship between existing chiller efficiency and ice storage savings is inversely proportional. The higher kW/Ton of an inefficient chiller allows for an ice storage system to provide more savings on a per ton basis.

Capital Cost – (The installed cost per Ton or Ton-hour, including ice storage tanks, heat exchanger, pump and ice making chiller).

The first cost of the system obviously has a great impact on the overall coast effectiveness of the system. In addition to the installation cost of the ice storage tanks themselves, there is a significant cost for the purchase of a specific ice making chiller. There can also be significant charges due to space constraints. For example, structural, support, extended piping, specialized tank sizes and rigging can all add significant costs to the project.

On the other hand, ice storage in many geographical areas has government subsidies available to off-set the cost of installation, and there are also some avoided costs that contribute to the savings of a project. New York State, for example, has the New York State Energy and Research Development Authority ("NYSERDA"). Ice storage projects currently meet the criteria for the Peak



Load Reduction Program that provides up to $475/kW reduction. Separately, ice storage capacity provides additional capacity/reserve for a facility's cooling capacity. In many cases, ice storage allows for a reduction in size of the planned central plant chiller capacity. For example, if the installed cost of the chiller itself is $600/ton, every avoided ton of refrigeration capacity related to the installed capacity of the ice storage system saves $600. Note that $600/ton is at the low end of the range. It highlights the fact that we already have supporting chiller equipment, such as cooling towers and pumps, in place. For a new installation, this number can exceed $1,500/ton.

One other economical benefit worth mentioning would be the ability to take advantage of more free cooling hours. Ice storage allows greater control during the switch over from mechanical to free cooling, allowing for the increase in hours of free cooling. Savings are estimated via – (additional hours of free cooling x chiller efficiency in kW/ton x average AC tonnage during free cooling periods x average all-in $/kWh).

Illustrative Example: Large Investment House in New York City

Goal – Management was looking for innovative ways to lower peak electric demand and increase reliability while lowering overall cost.

Result – An existing plant retrofit that incorporated 64 ice storage tanks, resulting in the following economics. Ice storage has been around for quite some time. At a time of increasing volatile energy costs and a greater need for controlling them, ice storage deserves a second look. As a reliable technology, it has basically proven itself many times over, and now with a better understanding of the economics, it appears to be a viable option from a financial perspective as well.

Ice storage has been around for quite some time. At a time of increasing volatile energy costs and a greater need for controlling them, ice storage deserves a second look. As a reliable technology, it has basically proven itself many times over, and now with a better understanding of the economics, it appears to be a viable option from a financial perspective as well.

Notes on Table:

1. The Ice Storage System in this particular project required the purchase of a dedicated ice making chiller and it included a Heat Exchanger. A dedicated chiller is not required in many instances, allowing for a significant drop in capital requirements.
2. As there was existing chiller support equipment in place, such as a cooling tower and pumping capacity, $600/Ton was utilized. Note that this number can exceed $1,500/ton when supporting equipment is considered.
3. Does not include slight increase in off-peak kWh consumption or the benefit derived from additional hours of free cooling.
4. Includes conservative flat block load profile with peak duration of 10 hours.

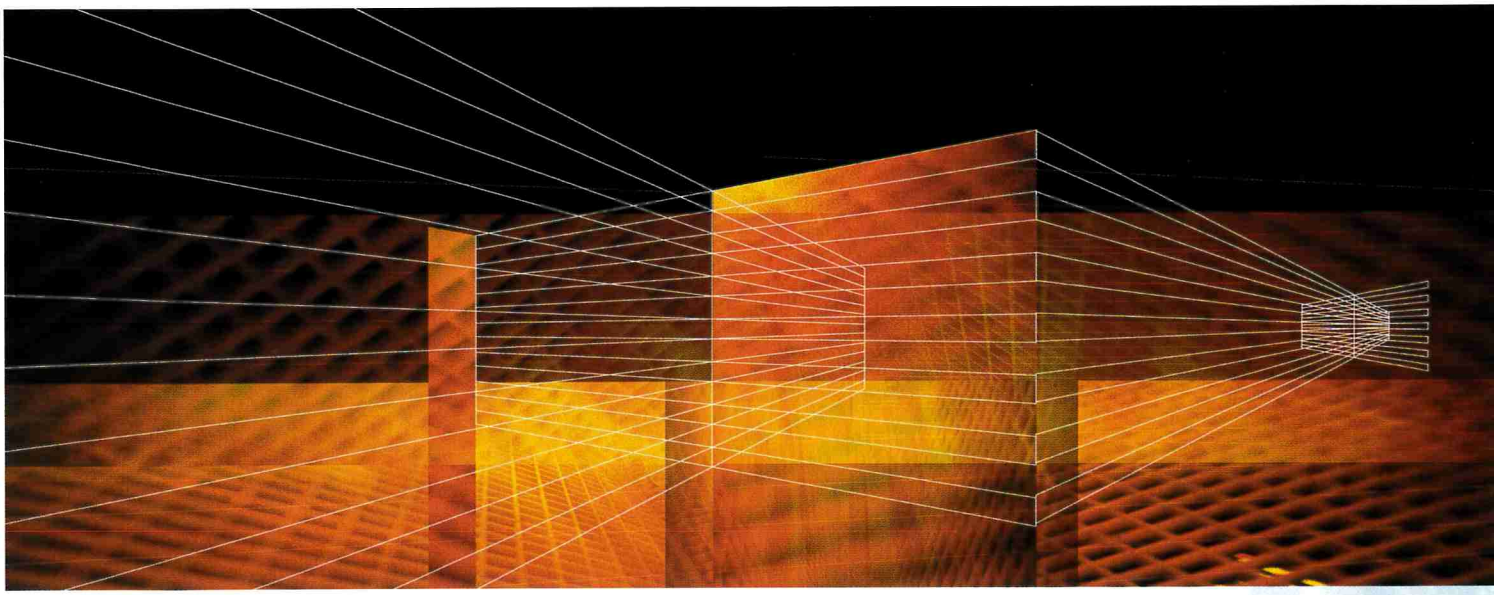
Although not every facility will be a strong ice storage candidate, a simple ice storage evaluation should be done for every facility.

Todd Coulard, *Account Executive, Energy Services, Trane New York, has over 15 years experience in the design and implementation of energy efficiency projects. He is currently responsible for the development and construction of large-scale comprehensive energy efficiency projects for Trane. He is involved in project estimating, budgeting, savings calculations, developing CPM's, and providing hands-on supervision and technical support to subcontractors. He often assesses client properties and evaluates site specific energy efficiency and capital improvement measures, with an emphasis on economic viability for clients and high profitability for the company. He develops Energy Performance Program proposals including financial analysis, financing options and statistical analysis of client energy consumption profiles. Mr. Coulard manages project implementation and adherence to performance criteria. Prior to joining Trane, he was Director of Facilities for The Durst Organization. He was involved in the commissioning of Four Times Square, the development of the 1155 Thermal Storage Project and implementation of energy efficiency measures throughout the Durst portfolio.*

Eugene Garcia *is President of ECM Energy Management Services. Mr. Garcia possesses more than 15 years of energy, engineering and finance related experience. He has provided operational and strategic planning to meet the needs of internal business requirements as well as those of external customers. His technical experience includes the design, procurement, and production of energy and its related systems. His market knowledge is derived from both domestic and international experiences related to the deregulation and privatization trends surrounding the energy industry.*

Ice Storage Simple Economics (Per Ton Basis)

Rates (ConEd NYC 2003 SC-9 Rate II):	
Peak Summer Demand	$33.5 / kW
Peak Winter Demand	$17.5 / kW
On-peak and Off-peak Variance	$0.03 / kWh
Load Profile	
Hours of Ice Melt per week-day	10
Months of mechanical cooling	12
Existing Chiller Efficiency	0.75 kW / ton
Capital Cost	
Ice Storage System – Install cost	$200/Ton-hour[1]
Avoided Capital – Excess Chiller Capacity	$600 / Ton[2]
NYSERDA Subsidy	$475 / kW
Profile Improvement	
kWh(s) Shifted from Peak to Off-peak	1,950kWh(s)[3,4]
kW shift from Peak to Off-peak	0.75 kW
Economic Outcome	
Demand Savings	$206
Energy Saving	$58
Total Savings	$264
Simple Payback	4 years



DISTRIBUTED GENERATION AND COMBINED HEAT & POWER

Chris Wissemann
Northern Power Systems

As electric consumption steadily increases in almost every aspect of our lives – home, office, factory or transportation – you might ask "where will all the power come from?" City, State and Federal planning agencies and regulators are confronted with the same question daily. Since there are few friendly neighborhoods that welcome thousand megawatt electric plants or high tension lines, Distributed Generation (DG) is attracting a lot more interest. DG means smaller electric generators located right where the power is consumed, instead of miles away in conventional power plants. Locating these mini-electric plants close to the loads (i.e., large buildings) opens up the door to certain configurations and technologies that make these plants much more economical and environmentally beneficial than conventional large utility power plants.

Combined Heat and Power

Distributed generation can include anything from solar photovoltaics powering homes, to utility owned "peaker" plants sprinkled around the countryside. This article, however, will focus on a subset of DG called Combined Heat and Power, or CHP. CHP is where a power generating system is configured to also gather and harness the waste heat associated with the power generation process.

CHP plants typically consist of engines (like cars) or turbines (like planes) powered by natural gas. CHP plants offer a tremendous efficiency advantage over typical utility plants due to the ability to economically recover the otherwise wasted heat. Whereas typical utility plants generate power at 35-40% efficiency, CHP plants generate power and thermal energy for a total efficiency of 70-75%. Imagine the impact of almost doubling the efficiency of power generation in the country. It would provide enormous environmental and economic benefits. Consider the impact on our national security and military budget if we could drastically reduce our reliance on importing fossil fuel from hostile nations.

Commercial Technologies

There are a handful of core technologies that can be used for distributed generation, but only a few of those are truly commercial – in that they can truly provide a reasonable return on investment without subsidies. As shown in Table 1, the true work horses of the DG/CHP industry are relatively old-fashioned engines and turbines that have been tuned to provide optimal efficiency and low emissions. It is important to understand that these technologies bear no resemblance to their diesel-fired, smoke-belching noisy cousins. Commercial DG/CHP can be configured so that they are innocuous boxes suitable for locating on rooftops in commercial environments, as shown in Figure 2 on page 107.

What Does This Mean For Me?

Regardless of the environmental and societal benefits of CHP, most decisions to proceed with a CHP system boil down to economics. A CHP system can reduce energy related operating costs by 50%. Installing a system in an urban environment will cost between $2,000 and $2,500 per kilowatt (i.e., roughly $4,000,000 for a

500,000 square foot building). A well-designed CHP system can provide a five to six year payback for a 15-20% return on investment. CHP systems can provide better returns when they are in simple-to-install environments, such as manufacturing facilities. Unfortunately, many buildings are not suitable for cost-effective CHP systems. Below is an outline of what makes for a good project and a few ideas of what to avoid.

Location: The property must be in a high electric cost region. Locations that work well for CHP systems are: California, New York, much of New England and in general, any utility that has electric rates above $0.10 per kWh.

Property Size: A basic axiom in CHP is that size matters. The vast majority of buildings above 400,000 square feet are good CHP prospects. Properties between 200,000 square feet and 400,000 square feet can be good if they have central heating and cooling systems that can serve as a recipient of the CHP system's recovered heating and cooling. In general, buildings below 200,000 square feet are more challenging in that few have central plants. For industrial properties, the physical size is less important than the electric and thermal loads.

Thermal Loads: Properties need to have accessible thermal loads – hot water, steam or chilled water. Finding a cost-effective home for the recovered waste heat, or installing a chiller to utilize the waste heat, is one of the costs that can quickly escalate, making a system uneconomical.

Physical Space: The location of the CHP system is extremely important in determining the cost effectiveness of a system. Ideal spaces in commercial office buildings are roof tops since they are little used. In larger buildings this is less challenging than it might appear since a CHP system requires only about 2,000 square feet of space. For industrial facilities, hospitals and even suburban office buildings, it can be ideal to locate the system on the ground adjacent to existing boiler/chiller rooms.

Other Considerations: Power quality and backup power are considerations that can make CHP systems very valuable. Many CHP systems can provide backup power in the event of a blackout. For industrial customers that are sensitive to the smallest blips, CHP systems can provide a steady source of high quality power.

Multiple Meters: CHP is very difficult in buildings where all tenants are direct metered. Due to utility interconnect rules, CHP systems can only be connected to a few meters cost effectively. This largely rules out residential properties, except for very small CHP systems serving base building needs such as domestic hot water.

Lease Structures: It is common that lease structures in commercial office buildings inhibit property owners from investing in this obstacle, there are a number of companies that will own and operate CHP systems and provide property owners with energy discounts and backup power services. The property owner obtains the benefits of the system without expending the capital.

CHP System: Choosing the right system and having it designed and installed properly is what makes a CHP system perform. It is very important to size a system properly, match the type of equipment to the loads, and integrate the system with the existing building so that it operates smoothly.

Most large consumers of power in high cost regions of the country could be well served by CHP systems. There are not many investments that provide strong returns, make energy supplies more secure and help the U.S. economy. Over the next few years, you can expect to see commercial deployment of CHP become much more prevalent in large urban markets.

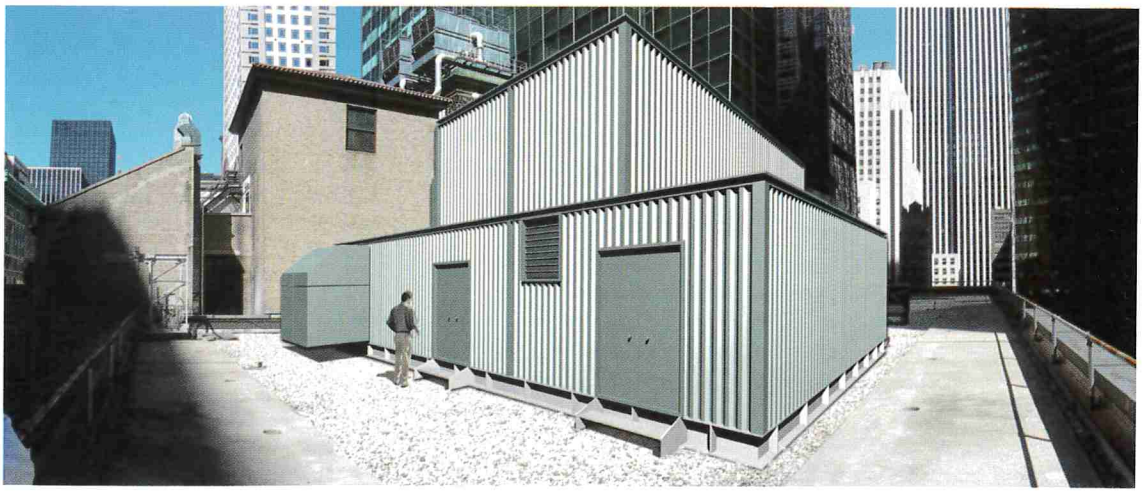
Chris Wissemann *is a Vice President of Northern Power and a 20-year energy industry veteran. He has developed distributed generation systems in New York, New Jersey, California and Massachusetts. He has extensive experience with energy efficiency projects and has developed multiple long-term contracts with electric utilities to sell efficiency derived capacity. Coupling technical and financial knowledge with commodity market knowledge, Mr. Wissemann offers unique insight into what it takes to make energy-related projects truly economic.*

TABLE 1

TECHNOLOGY	DESCRIPTION	FEASIBILITY
Reciprocating Engines	Piston Driven Engines Like Auto Engines	Commercially Feasible. The bread & butter of DG
Micro-Turbines	Small turbines < 500 kw Like Jet Engines	Commercially Feasible. Viable where lots of thermal energy is required.
Turbines	Larger turbines > 1 MW Jet engine derivatives	Commercially Feasible. Viable for large projects where lots of thermal energy is required. (Primarily Industrial)
Fuel Cells	Space age technology that creates electricity from a chemical process with few moving parts	Not Financially viable without subsidies.
Solar Photovoltaics	Direct conversion of sunlight into electricity using silicon	Not Financially viable without subsidies.

FIGURE 2

Planned CHP System on Roof of Midtown Manhattan Office Building



GEOTHERMAL AT THE CENTER FOR ARCHITECTURE

Rick Bell, FAIA,
AIA, New York Chapter
Joyce Lee, AIA
NYC Office of Management and Budget

If architecture is to be grounded in the earth, the Center for Architecture has achieved just that by going 1,260 feet into the bedrock of Manhattan. Spurred by a grant from the New York State Energy Research and Development Authority (NYSERDA), Architect Andrew Berman, AIA and Engineer Michelle Noris, PE have designed an energy efficient heat pump system that has few, if any, counterparts in the region in a publicly accessible building.

The Center for Architecture, the new home of the American Institute of Architects (AIA) New York Chapter and the New York Foundation for Architecture, is located in the heart of Greenwich Village in New York City. The 536 LaGuardia Place location had been chosen because of the demographics of movement by architecture and design firms towards Lower Manhattan, as well as the AIA's desire to have a storefront presence. The Center's mission of civic engagement is exemplified by Chapter events involving the public sector, collaboration with a wide variety of other professional organizations and not-for-profit groups and a range of exhibitions pertaining to the public realm.

Daylight penetrates deep into the ground floor "public resource center" lobby, the "common room" library and two subterranean levels containing galleries and a lecture hall. Transparency and accessibility are recurrent themes. The design is the antithesis of an 18th century gentleman's clubhouse or its later day equivalent. The glazed storefront facade strives to engage everyone, from students and community residents living nearby to the overseas culture seeker who studies the New York City subway map to find the Center just south of Washington Square Park.

Why Geothermal?

From the context of design, why celebrate a geothermal system when most of it is hidden underground? The answer is deceptively simple: its design appeal stems from the system serving a much needed cooling and heating function without the usual clutter of mechanical equipment and the predictable noise of the fans at the rooftop. This design freedom can be particularly valuable in urban buildings with restricted rooftop access and in the renovation of historically significant structures where the roofscape cannot be altered.

Using the latent heat storage capacity in the earth is an effective way to reduce the urban heat island effect. The geothermal systems eliminate the need for rooftop cooling towers which releases heat into the atmosphere. It is also good news to local botanists when the constant evaporative effect from the cooling towers is absent, thus allowing better survival opportunities for plant species nearby the building.

An article by Peter Hall in the May 2004 issue of Metropolis magazine described the geothermal system at the new Center for Architecture. Hall's description, "a network of white plastic pipes gurgles and guzzles around a heat pump like the arteries of a newly transplanted heart," hints at the organic importance of the

geothermal system to the new space. When the AIA decided to move from its uptown aerie at the New York Design Center at 200 Lexington Avenue, green issues were at the forefront of site analysis, program development and architect selection.

The location purchased by the AIA, across from Neil Estern's statue of Fiorello LaGuardia, presented significant challenges. A storefront with a 5,000 square foot floor plate came with basement and cellar levels of equivalent area. These dark and damp spaces were barely usable for storage. An east-facing storefront allowed light to penetrate into the former poster shop interrupted by columns and randomly placed interior partitions. But the possibilities seemed unlimited. An open two-stage design competition was organized with a program brief that stressed creative environmental solutions. The eight green criteria in the program included the requirement to "embrace design features that combine environmental and educational value." The competition winning firm, Andrew Berman Architect, went beyond the program requirements to open up the three levels of space to natural light, enhancing visibility and transparency of AIA operations and Center activities.

The design entails removing almost 2,000 square feet of concrete slab to create double and triple-height lecture and gallery spaces, resulting in 12,000 net square feet with a permissible occupancy approaching 500 people. The AIA as client, along with their architects and engineers, considered early-on the use of geothermal heat exchange for both heating and cooling. There are several reasons why this became the choice for the Center for Architecture:

- It consumes over 30% less energy than a conventional condenser-type air conditioning system
- It does not require large heat transfer grilles on the façade of the building
- It preserves all the valuable window openings and daylighting opportunities on the ground floor
- It could be installed as new technology in the retrofit of an existing building
- It did not require adding a cooling tower to the roof of an occupied building with seven floors of live-work lofts above the ground floor

The 65-ton system designed by Michelle Noris, PE of Norfast Consulting Group, with advice from William Bobenhausen, FAIA (then of Steven Winters Associates, now president of Sustainable Design Collaborative, LLC) is the first geothermal heat exchange installation used for a public space in New York City. The closed-loop system has standing column wells, which extract cool water from the bottom of the well and replace the heated water at the top. The heat exchanger has two fluid loops: the ground water loop and the secondary loop. The heat exchanger functions to isolate the ground water from the heat pumps and piping, preventing potential sediment problems in the heat pump coils. The Center has several other features to enhance energy efficiency. The heat pumps are zoned by use, so only occupied spaces are heated and cooled accordingly. The fresh air supply fan and the secondary water pumps are both on variable frequency drives. Such modular efficiency is particularly well suited to a building with daily schedules and occupancy as varied as the Center.

The grant from NYSERDA significantly offset the $100,000 cost of the drilling of the two wells, each 1,260 feet deep. With proper permitting from the City's Department of Transportation and Department of Environmental Protection, the well drilling took place over a three-week period in the summer of 2003, shortly before the Center for Architecture opened to the public on October 7th.

Each well took a week to drill, with the relatively noisy activity taking place only in the afternoons to mitigate intrusive acoustical annoyance in a Village community of late nights and later mornings. Set-up and moving of the drilling rig in the street and hay bales for water containment took an additional week. One lane of traffic remained open, and the sidewalk in front of the Center, protected by safety barricades, also stayed open for passage throughout the drilling period.

Other Examples

Buildings can become pedagogic tools for their inhabitants and visitors. For example, in Boston, where the mayor has recently convened a green building task force, Richardson's Trinity Church is being renovated by Goody Clancy Architects, who have incorporated wells dug deep under Copley Square. Mechanical equipment could clearly not have been added to the top of this landmark structure visible on all sides from the public square.

In the New York region, geothermal systems are found in a variety of buildings, including the Bard College Performance Arts Center by Frank Gehry and the 1400 Fifth Avenue affordable housing project developed in Harlem by Full Spectrum. The Front Street residential project by Cook + Fox Architects brings geothermal to market rate housing in Lower Manhattan's South Street Seaport historic district. The new Queens Botanical Gardens administration building by BKSK Architects will break ground this year with the latest geothermal installation.

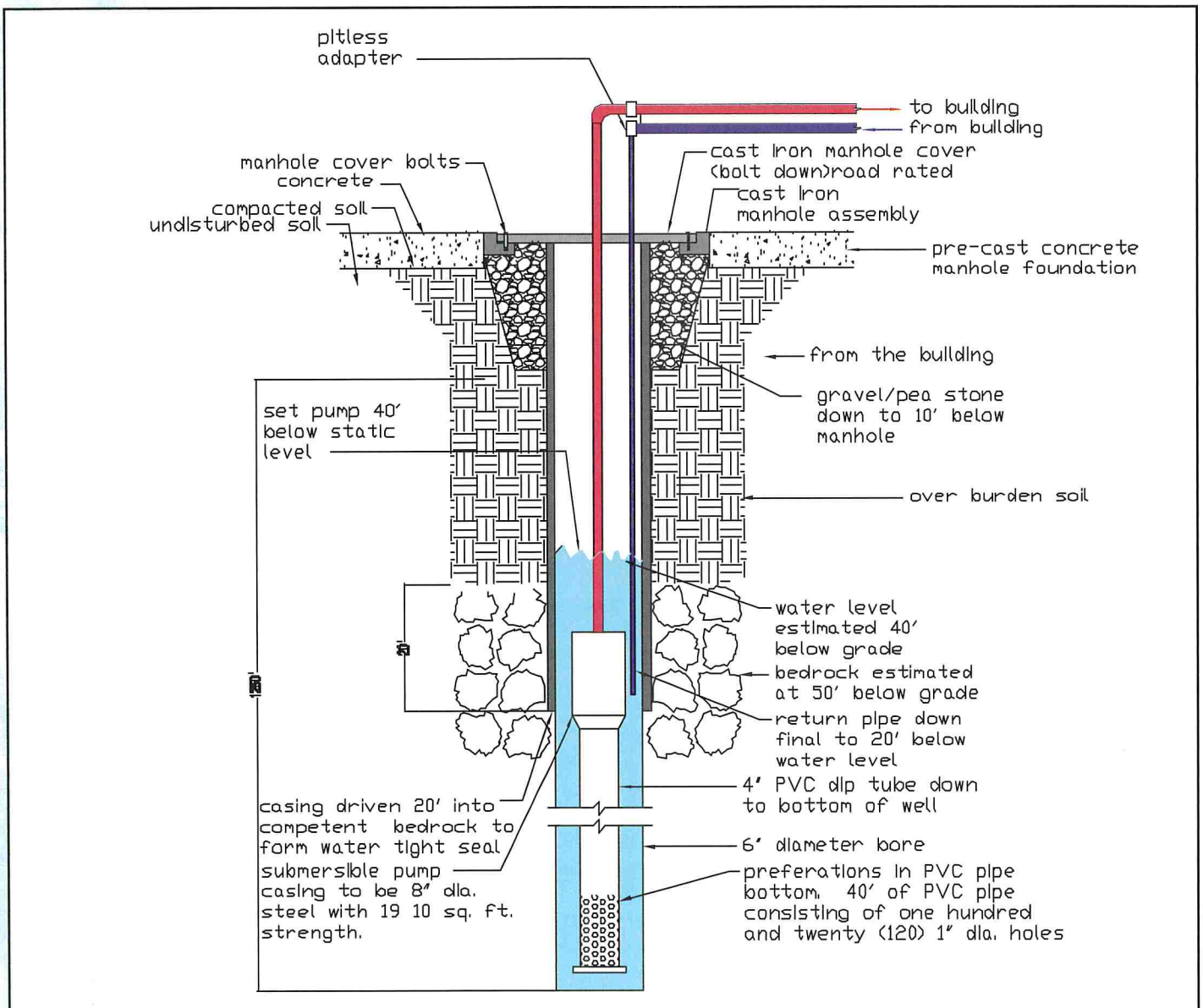
Other projects on the drawing board include Kensington Library and Weeksville historic house from the high performance buildings portfolio at the New York City Department of Design and Construction. More recently, the system is also being considered at Fort Tryon Park by the New York City Parks Department because of the potential microclimate improvement for flora and fauna nearby.

Technology of the Future?

The fact that geothermal systems are starting to be used more widely in New York City and the region is remarkable. Even more remarkable is that this relatively simple technology is seen as futuristic. The City, along with NYSERDA, was far-sighted enough to have given capital support to the creation of the Center. The advice and consultations from the New York City Economic Development Corporation, the Department of Buildings and the Department of Cultural Affairs were invaluable. Visitors to the Center for Architecture who witness the quiet pipes at work and feel the cool air wafting freely inside on a hot summer day can only say that they have seen the future, and the future is here.

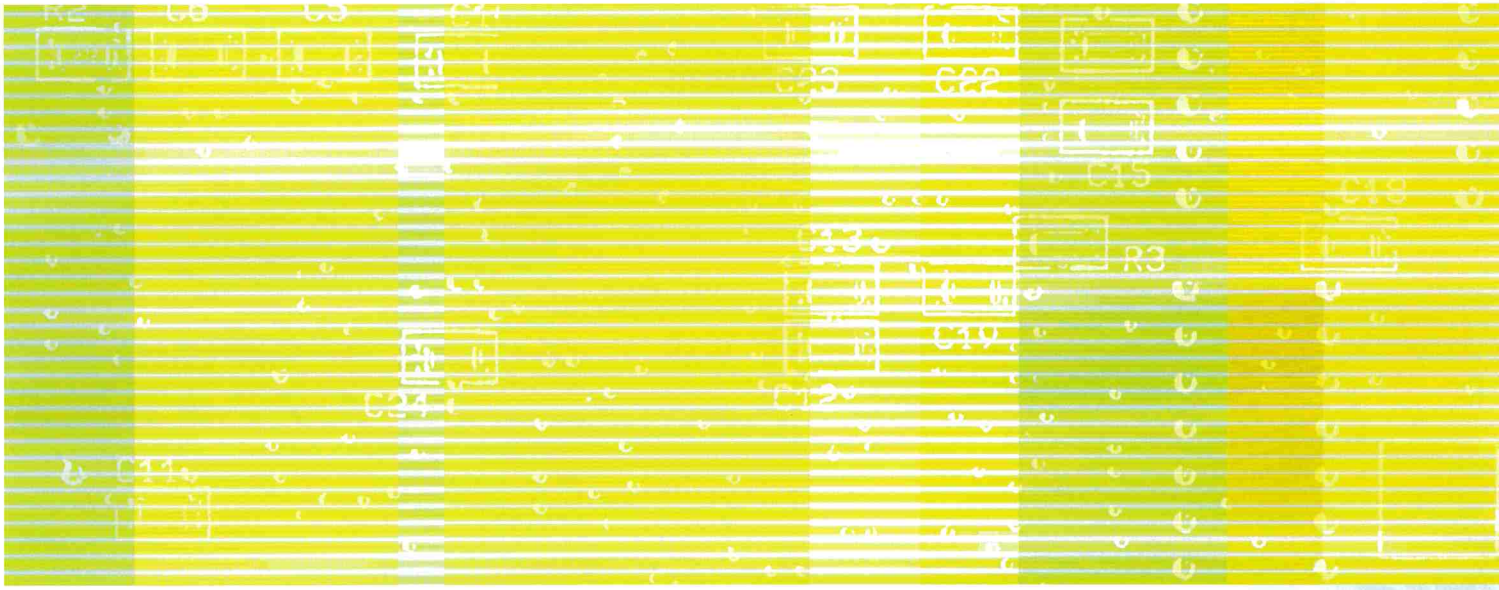
Rick Bell *is executive director of the New York Chapter of the American Institute of Architects. At the AIA, Rick has worked to raise the profile of the architectural community on public policy issues, including accessibility, preservation, quality based selection, and sustainable design. He previously was chief architect and Assistant Commissioner of the NYC Department of Design & Construction, where he had responsibility for design excellence and helped create the City's High Performance Building Guidelines.*

Joyce S. Lee *serves as Chief Architect at the New York City Office of Management and Budget and is a former board member of the AIA New York Chapter. In 2002, she was chair of the National AIA Committee on the Environment, and most recently received the AIA NYS President's Award for Professional Contribution.*



WELL DETAIL

Courtesy of Michelle Noris, PE and Rafael Jaquez



DISCOVERING THE FIFTH FAÇADE: GREEN ROOFS MAKE GOOD SENSE

Amanda Clontz
Earth Pledge

For well over 30 years, air pollution, increased urban temperatures and stormwater challenges have been mitigated by green roofs in European countries. These same problems persist in U.S. cities today amid increasing interest in green roof implementation on this side of the Atlantic. Built atop typical insulation and waterproofing, these lightweight, engineered systems nurture soil and vegetation with layers for filtration, drainage and root control. Rooftops are no longer just for the birds. We're transforming this fifth façade into a valuable, green amenity for tenants and the surrounding community. Green roofs offer a sensible opportunity to better our urban neighborhoods.

The Environmental Benefits of Planting a Roof

Because city water treatment plants have limited capacity, rainstorms often result in the disturbing discharge of contaminant-laden runoff and raw sewage directly into surrounding waterways. This Combined Sewage Overflow (CSO) is familiar in many mature cities with common stormwater and sewage pipelines. Urban green roofs lessen water treatment plant loads by retaining much of the stormwater that hits their surface. As more buildings install green roofs, the volume of stormwater entering city sewers and the potential for CSO will decrease. Beyond the benefit to the community, green roof stormwater management can also allow for installation of smaller drainage pipe systems on new construction projects, lowering overall plumbing costs.

Environmental advantages of green roofing go beyond water retention. The sizable thermal gradient that exists between developed and undeveloped land is consistently marked by temperatures ranging 5-10 degrees warmer in city environments. Layers of cool vegetation effectively reduce the islands of heat we've inadvertently created with our big glass and concrete structures and dark paved surfaces. This ambient cooling takes place on garden roofs through evapotranspiration, involving the transfer of water both from the soil by evaporation and by transpiration up from the plant roots through the leaves as water vapor.

While the leaves help to cool the air, they can also clean it. Airborne pollutants, including heavy metals and greenhouse gases, cause and further agitate a number of health problems, especially asthma in children. Like plants at any altitude, rooftop vegetation is a sponge for collecting these fine particles from the air, which rainwater then rinses into the substrate. The air cleansing power of each plant varies based on size and surface area of greenery.

LEED and Green Roofs

Many are turning to the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) standard to earn certification for greening their buildings. These project teams care about making green building standard practice and they know their tenants will also. LEED can be used as one tool to help maximize the sustainability and market value of a building and its components, including green roofs. A green roof can independently earn or contribute earning power to a number of LEED credits, enhancing a project's sustainability rating:

Sustainable Sites c6.1 – *Stormwater Management, Rate + Quantity*
Green roofs contribute a great deal to reducing stormwater rate and quantity, collecting and storing much of the rainwater that hits their surface and releasing some of it back into the atmosphere via evapotranspiration. Most research demonstrates that annual stormwater runoff on a green roof is 50-80% reduced as compared with a conventional roof.

Sustainable Sites c6.2 – *Stormwater Management, Treatment*
Because stormwater is retained in vegetated roofing, the overall pollutant load released to stormwater systems is reduced. Phosphorous-containing fertilizers should be avoided, if possible. However, slow release fertilizers are typically a good choice; more of the nutrients are used and less is washed away to potentially pollute runoff.

Sustainable Sites c7 – *Heat Island Effect: Roof*
Green roofing alone, or combined with high-albedo roofing, can earn this credit for lowering ambient temperatures associated with development.

Water Efficiency c1.1 – *Water Efficient Landscaping, Reduce by 50%*
High-efficiency irrigation technology, or captured rain, or no permanent irrigation for landscaping can reduce potable water consumption for landscape irrigation.

Water Efficiency c1.2 – *Water Efficient Landscaping, No Potable Use or No Irrigation*
Only captured rain or recycled site water may be used for permanent irrigation (except for initial "starter" watering). Compliance can also be earned by not installing any permanent landscape irrigation.

Energy + Atmosphere c1 – *Optimize Energy Performance*
Green roofs lower overall heat gains of a building in summer and add extra insulation to the rooftop in winter.

Materials + Resources credits 4.1 + 4.2 – *Recycled Content = 5% + 10%*
Components of the green roof structure and planting media can contain recycled content.

Materials + Resources c5.1 + 5.2 – *Materials Manufactured + Extracted Regionally*
Portions of the green roof may be able to be harvested and/or manufactured within 500 miles.

Innovation + Design ID c1-4
Innovative green roof measures could qualify for exemplary sustainable measures above and beyond the LEED standard.

The environmental benefits of a vegetated roof are many but there are also economic benefits.

Economics of Green Roofs
The first cost of a green roof will inevitably be more expensive than that of a standard roof system; there is more material and labor involved, and often more design too. Nonetheless, green roofing is an investment with substantial payback, monetary and otherwise.

Whether it is a roof "meadow" planted with sedum and grasses, an herb garden or a gathering space, green roofs add valuable amenity to a building, transforming otherwise dormant building zones into secure oases of green. With the ever-increasing density of urban areas, utilization of rooftops as a multi-functional "fifth façade" is smart development that can greatly increase property value to benefit the owner and the inhabitants. Green roofs of all kinds draw tenants, even if not accessible due to shallow soil depths. A green roof view is valued as well, and is much preferred to a conventional asphalt roof.

Green roofs are also less likely to leak than conventional rooftops, despite increased water retention. The layer of substrate and vegetation protects the otherwise exposed waterproofing below from heat and ultraviolet rays and related degradation. The green roof also protects the membrane from thermal expansion and contraction, preventing eventual cracking and leakage. Conventional roofing systems typically require repairs and re-waterproofing after 12-15 years due to solar and heat stresses, whereas a green roof typically lasts more than twice as long. Therefore, the expense and hassle of membrane maintenance over the years is avoided with green roofs.

Ensuring the Integrity and Economic Benefits of Green Roofs
To ensure all the above benefits are maximized but also economized, careful planning must be undertaken from green roof inception to maintenance over the years. The following tools and strategies can help.

Electric Field Vector Mapping is a form of leak detection that can be installed during construction of a roof, to test for water-tightness before adding the green roof components. The system can then remain in place for future membrane testing, as needed. Leaks do occur with less frequency on green roofs; yet, to avoid disruption of established plant life, and to save time and money, these leak detection systems prove helpful.

Expert input throughout the planning process can help ensure a healthy green roof that fulfills project goals and economics. Each of the following aspects should be thoroughly addressed, with careful attention to relationships between choices:

- Project Schedule and Budget
  - When to plant to maximize integrity
  - Labor and materials costs
- Green Roof Type / Accessibility
  - Extensive (2-6 in. of substrate)
  - Semi-Intensive (6-12 in. of substrate)
  - Intensive (12+ in. of substrate)
- Structural Load Implications
  - Saturated green roof weight
  - Live loads (if roof is accessible)
  - Wind shear
- Complete Green Roof System, or Collation of Individual System Components
  - Warranty implications
  - Cost implications
- Green Roof Materials
  - Locally manufactured and/or harvested
  - Recycled content opportunities
- Plant Types
  - Required substrate depth
  - Number of species planted together
- Planting Methods
  - Vegetation mats, plugs, cuttings or seeds, or spontaneous colonization
  - Related cost and coverage
- Substrate
  - Water retention and drainage properties
  - Weight and depth
  - Nutrient capacity
  - Pre-mix or on-site mix
- Irrigation
  - Is it necessary?
  - If so, type: spray, capillary, drip and tube, or standing water
- Green roof maintenance
  - Fertilization requirements
  - Proper drainage
  - Weeding

Every existing roof and new construction project provides a chance to green a roof. Every green roof project is an opportunity to greatly enhance a blank slate in the sky and impact a community. Greening rooftops makes good sense.

Amanda Clontz *is a director of the Green Roofs Initiative (www.GreeningGotham.org) at Earth Pledge, a non-profit environmental foundation in Manhattan where she is promoting an understanding of vegetated roofs and how they better the built and natural environment. She also plans and builds green roofs. She has practiced sustainable architecture with firms such as Studio Petrarca and Cook + Fox Architects, working on geothermal townhouses on Reade Street in Tribeca and the Bank of America headquarters at One Bryant Park. With e4 inc., Amanda worked as an environmental building consultant on The Helena, a residential tower and the St. Francis of Assisi, a mixed use project, both working toward LEED Certification.*

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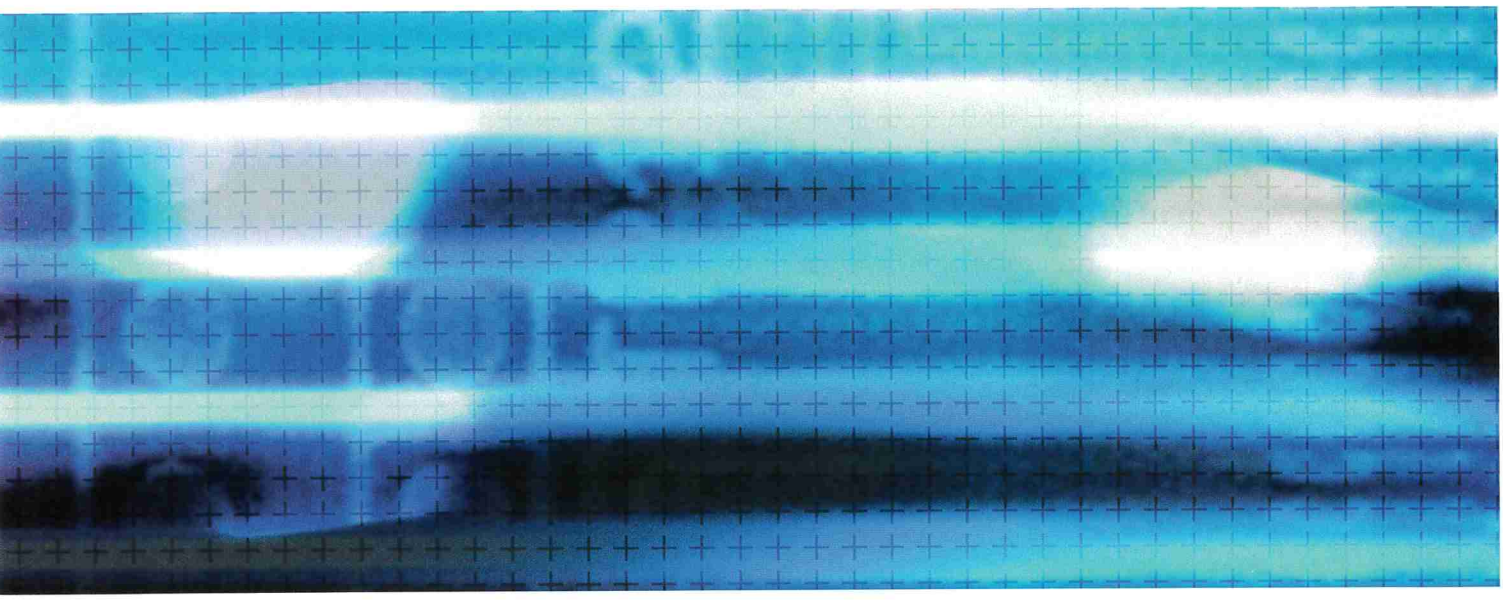

THE CM'S ROLE IN ACHIEVING LEED CERTIFICATION

Michael Deane
Bovis Lend Lease

What role does the Construction Manager (CM) play in a LEED® project? How is the role different than in a comparable non-LEED project? What does the CM do during design, procurement, construction and close out that is critical to achieving LEED Certification? What makes the difference between a smoothly run, cost effective project and one that experiences delays, frustrations, added cost and, in the worst case, fails to attain certification?

The CM's job is to advance the owner's interests. Most simply put, our job is to build the job "on time and on budget." An experienced green CM can make designing and building a LEED project much easier and less expensive.

Whether public sector or private, no one should be surprised that an owner's first question about green building is, "How much is this going to cost?" Nor that the most common approach to choosing LEED points is on a first cost basis, pursuing the least expensive points to achieve the desired level of certification.

A good CM can help an Owner understand the true costs and benefits of sustainability. To accurately assess the cost of green, one needs to consider not just construction costs, but operations & maintenance costs as well. Traditionally, construction dollars (first costs) are budgeted and spent with little regard for future operating expenses. In fact, they should be linked. When life cycle costs are taken into account, it becomes apparent that lower operating costs can recoup higher first costs in a reasonable time frame, often in one or two years. When considered as an investment rather than an expense, an increased first cost with a five year pay back period is a 20% Return-On-Investment.

A green CM is capable of evaluating first cost, life cycle costs and O&M costs for various options, and can prioritize LEED points to allow the Owner to realize the true value of first costs over time.

As sustainability has become more mainstream, cost differences between green and non-green approaches have been reduced or have even disappeared entirely. Whether because of supplier competition for this new and growing market or because of contractor competition to get the job (and probably a combination of both), many products such as low VOC paint, non-urea-formaldehyde particleboard, recycled carpet and 100% recycled sheet rock, have all become virtually cost-neutral and widely available.

This means the Owner and the design team have more choices within their budget to select green solutions. A good CM will know the current market costs and availability of materials and equipment, and can assist the design team in reaching a cost effective and environmentally responsible solution.

Ideally, the CM is involved from the beginning of the design process to provide accurate cost estimates and advise on the constructability of various design scenarios during preconstruction.

During pre-construction, a green CM can help identify products that contain recycled content and/or are harvested and manufactured regionally. They review MEP specifications for energy and water use and impact on indoor environmental quality.

During procurement, a green CM can develop scopes of work that specifically call out LEED requirements for each trade, including documentation and submittal requirements. Subcontractors will know exactly what is expected of them and can price their bids accordingly but in a competitive environment.

A CM practiced in this field will be able to present to the Owner a list of bidders with sufficient green expertise to do the job. The CM will negotiate the best price, making sure it is not inflated with any "fear factor" mark-up and will stop bidders from artificially inflating the cost of allegedly "hard to find" green materials. A knowledgeable CM can assist subcontractors through the procurement and documentation requirements, which keeps their costs down. These savings are passed directly onto the owner.

When bidding, the CM should meet with all proposed bidders to ensure they have a detailed understanding of the green requirements of their trade and the job as a whole. Once the trade awards are made, the CM should continue to meet with subcontractors (typically weekly) until all documentation is submitted and all work is complete to ensure full compliance.

During construction the CM must closely monitor submittals for compliance. A thorough understanding of LEED ensures that no points are lost due to carelessness or failure to obtain complete and accurate documentation. Due to the LEED certification process, the project team is largely on its own through design and construction. It is not until the project is complete and often occupied, that documentation is submitted for review. It is disheartening to think that after one or two years of effort, your project may lose points, or even certification, because of sloppy documentation or bad recordkeeping. Accurate and complete documentation is critical to success.

There are four levels of LEED certification: Certified, Silver, Gold and Platinum. Interestingly, the USGBC reports that submissions of LEED Silver and Gold projects are often easier to approve than certified projects. The reason may be that the more experienced project teams are familiar with the credit requirements and do a better job of documentation. The less experienced teams aim lower because they have less confi-

dence in their knowledge and have a harder time with compliance and documentation. Experience counts.

Of the 69 possible LEED points, most are design driven and achieving them is determined largely by the A/E team in accordance with the Owner's program and budget. While the CM can have significant overall input when involved early in the design process (always a good idea), there are at least a dozen LEED pre-requisites and points that are directly or indirectly dependent on the CM. Experience and understanding the LEED Rating System can make a real difference in time and money spent, and can help ensure the project actually achieves the targeted points.

Success with Erosion & Sediment Control and Basic Commissioning (both prerequisites), Construction Waste Management (2 pts), Indoor Air Quality During Construction and Pre-occupancy (2 pts), Additional Commissioning (1 pt), Low-emitting Materials (4 pts.), Recycled Content, Local and Regional Sources, and Rapidly Renewable Materials and FSC Certified Wood (6 pts) is dependent on the CM's diligence during procurement and construction. The CM can also provide the project with a LEED Accredited Professional (1 point), and be responsible for one or more of the four possible innovation credits.

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A green CM can also manage the paper trail for LEED certification. Bovis Lend Lease, for instance, has developed spreadsheets that track points and current status as to open and closed items. Items are carried as open until all required documentation is in hand. This matrix is included as part of the Monthly Report to the Owner.

During construction, as with any non-LEED project, the CM will monitor and document all submittals for compliance with the specifications, including LEED requirements.

Construction waste is tracked and reported monthly by material category, percent recycled for each material type and final destination of all waste, recycled or not.

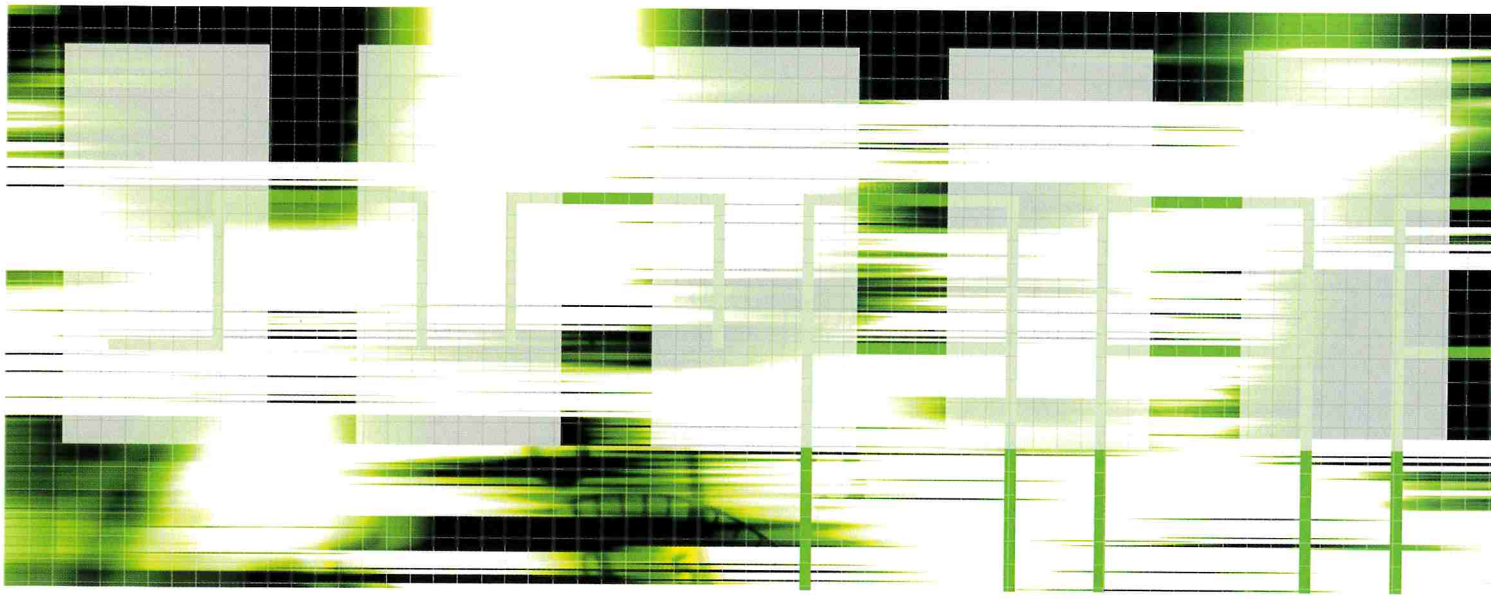
Submittals management must include all required O&M manuals to ensure that equipment functions to design specifications. O&M manuals will be used by building management, and to assist in the commissioning process.

The CM's role is critical in monitoring construction site activity to ensure compliance with site management protocol, construction waste management, erosion and sediment control, indoor air quality during construction and in meeting commissioning requirements.

At the conclusion of the project, all LEED documentation can be turned over to the Owner for formal submission to the USGBC, or the CM can directly manage the submission process.

To be truly successful, a thorough knowledge of LEED must be integrated into all members of the team. The CM will be less successful if green is an afterthought or an add-on. A CM firm just venturing into sustainable projects and without in-house expertise, may begin by outsourcing the LEED management to a specialty subconsultant, but long term success (especially in the face of increasing competition) will be won by those firms who take the knowledge in-house and make it part of their building culture.

Michael Deane *is a Senior Project Manager with Bovis Lend Lease. He is a founding member and current Chair of the Board of Directors of the US Green Building Council-NY Chapter, and a LEED Accredited Professional. He is presently working on two LEED registered projects, 325 North End Avenue, a 24-story residential tower in Battery Park City, and Clinton Green, two 24-story residential towers and a theater in the Clinton section of Manhattan.*



21ST CENTURY DEMOLITION

Robert Licopoli
Skanska

While demolition may not sound like a hot topic, these days there are some exciting new directions in demolition in the construction industry that many people may not realize are taking shape and could benefit from discovering.

Deconstruction is a term that is becoming synonymous with diversion for reuse and recycling activities during demolition. Traditionally, laborers entered a building with shovels and sledge hammers and would demolish the building from the top floor down. Increasingly, owners and demolition contractors are exploring ways to remove material in a reusable form, decreasing tipping fees and creating a secondary market for lower-cost building materials that would otherwise end up in a landfill or scrap heap.

In a notable milestone, the Mason Tenders Training Fund is leading the way in teaching laborers how to properly deconstruct a building. The Training Fund provides education on how to selectively demolish structures so that material reuse can be optimized. This includes doors, trim, lighting and more. However, due to possible litigation and building code violations, these materials are rarely reused in the projects where they are removed, especially in New York City where older structures are frequently replaced with Class A office towers or residential projects.

Nevertheless, reuse centers are being established around the country, many being run by Habitat for Humanity, to provide low-cost building materials to small businesses or home owners or landlords that are eager to keep costs down. Many of these reuse centers are non-profit organizations involved in local economic development and can offer a tax deduction for the materials, which in turn provides financial benefits to the owner as well as the demolition contractor.

In New York City, considered one of the toughest markets in the country, the Community Environmental Center (CEC) is launching a reuse center. In many cities, local governments have provided grants and/or supplied free or subsidized space to help start and sustain these efforts, which will simultaneously help to divert waste from landfills and foster economic development in low-income communities.

The number one issue facing selective demolition is not the cost, rather it is communicating and marketing the fact that these materials even exist and are available to people who need them. The most common materials that are reused include bricks, doors, sinks, studs, joists, mechanical equipment and flooring.

Based on independent data provided by a New York construction management firm, and a New York-based carting company, an average of 75 percent of their construction demolition (C&D) waste is regularly diverted from landfills. This translates into a $375 savings on a $500 dumpster. On the back end, it costs an average of four man-hours per dumpster that is spent sorting materials. Based on New York City's highest labor rates, this translates into an additional labor cost of $240. There is a bottom line profit of $135 per dumpster which does not include any tax deductions

or income from materials that may be sold.

Nationwide, C&D debris accounts for 25 percent to 45 percent of the total solid waste stream (by weight), with the balance consisting of regular municipal and commercial trash. In New York City, C&D accounts for more than 60 percent of the solid waste stream, according to a recent study by the New York Department of Sanitation (DOS). In the 1990s, tipping fees for disposal at transfer stations in Manhattan were in the $50 per ton range. Currently, they are in the $70 to $80 per ton range and are expected to continue to rise.

Deconstruction contributes to improving the environment, to economic development in disadvantaged neighborhoods and ultimately helps both owners and contractors save money.

Robert Licopoli *is the Director of Environment, Safety, Insurance and Litigation for the New York office of Skanska USA Buildings. He has been with Skanska since 1998 and in this position in New York since 1999. Robert attended Millersville University under the Occupational Safety and Hygiene Management program. Millersville's safety program is only one of 8 accredited programs, nationwide. After college Robert spent 5 years working for Day and Zimmermann specializing in Pharmaceutical, Petrochemical and Micro-electronic construction and engineering. In addition to his day job Robert is the Founder and President of the North American Football League, the world's largest adult Football League. He is married with a one year old son and another due in March.*

AVOIDING MOLD THROUGH GOOD CONSTRUCTION AND MAINTENANCE PRACTICES

Eileen Lee, Ph.D.
National Multi Housing Council

For the past several years, "mold" has been a four-letter word to most of the real estate industry. Its discovery in water-damaged libraries, courthouses, schools, apartments, offices, hotels, warehouses and single-family homes across the country triggered concern and lawsuits nationwide, including high-profile complaints from celebrities such as Michael Jordan and Erin Brockovich.

Fortunately, a recently released study by the National Academy of Sciences (NAS) offers some perspective on this issue. The study – titled *Damp Indoor Spaces and Health* and conducted by the Institute of Medicine (IOM) of the NAS – concludes that some of the worst threats about mold have not been substantiated. There is no way to isolate mold as the cause of illness because there are too many other factors (including degraded building materials and furnishings, as well as biological elements such as dust mites, bacteria and cockroaches) in the typical indoor environment that could influence health.

Nevertheless, property owners still need to deal promptly and effectively, and if possible, proactively with moisture intrusion. Improved construction techniques, materials and a comprehensive operations and maintenance plan remain the most effective way to deal with these issues.

Prevention is the Best Cure

Making buildings water tight has always been a top priority for designers and builders; however, increased attention to the issue of mold and moisture intrusion has underscored the importance of monitoring the construction process. Even when materials (e.g., sealants, caulking, flashing and roofing membranes) are appropriately specified, they must be properly installed. Any penetration of the building envelope such as windows, doors and balconies can pose a potential for moisture intrusion. It is important to monitor the installation of these details during construction in order to prevent problems later.

Building products like caulking and sealants do not last forever and they must be monitored and repaired throughout the lifetime of the structure. Materials should be inspected before they are used; anything that appears water-damaged should be avoided. Field changes should be analyzed for their impact on the airflow through a space. For example, reconfiguration of walls can affect airflow through a structure and result in areas with high relative humidity. HVAC designers should approve these changes. Even in buildings that are properly designed and constructed, the building commissioning process is an essential step in assuring that the building is operating as designed.

The Key: Routine Maintenance

If property owners do find damp conditions, they should isolate the source of the water, remove or repair any damaged materials and take appropriate measures to clean up any mold. According to the U.S. Environmental Protection Agency (EPA), "If you can see mold or smell

mold, you need to remediate." (The EPA does not recommend that owners test their properties because it is not necessary to identify the type of mold in order to remediate.)

A property owner should hire an experienced remediation contractor to carry out the cleanup. If the scope of the problem is unclear, a building scientist or certified industrial hygienist should be consulted to help develop a plan for mitigation and ongoing maintenance. Depending on the scale of the remediation effort, a building owner may ask the remediator to provide a "clearance report" when the project is completed. Keep in mind that there are no federal standards regarding what levels of molds are "safe." Environmental reports that reference molds simply measure the indoor air in comparison to outdoor air taken at the same property, during the same period of time.

A Shared Responsibility

Property owners should also continue to educate their tenants and residents about the shared responsibility for managing moisture in the building. While the property's management is responsible for the structure and its systems, residents control many moisture and hygiene issues within the space they occupy. In addition to performing standard housekeeping, they need to understand how important it is to report moisture problems to their building's management immediately.

In its brochure, "A Brief Guide to Mold, Moisture, and Your Home," the EPA recommends that if a tenant or resident experiences indoor dampness, he or she should:

1) Fix plumbing leaks and other water problems as soon as possible and dry all items completely.
2) Scrub mold off hard surfaces with detergent and water and dry completely.
3) Do not paint or caulk moldy surfaces. (Paint applied over moldy surfaces is likely to peel.)

More Research Necessary

Though several courts have already cited the NAS report in denying verdicts to plaintiffs alleging certain illnesses as a consequence of mold exposure, it is hardly the last word. In its recommendations, it calls upon the U.S. Department of Housing and Urban Development and other appropriate government agencies to help develop consensus guidelines on building design, construction and operation/maintenance to prevent dampness problems. It also calls on the government and the private sector to educate building professionals (architects, builders, facility managers and maintenance staff, code officials and insurers) on how to prevent dampness problems.

The Damp Indoor Spaces and Health study also places property owners on notice that indoor air quality is a hot button issue. Until regulations are developed, owners are advised to implement an operations and maintenance plan to deal with moisture intrusion and mold on their properties.

Eileen Lee, Ph.D., *is Vice President of Environment of the National Multi Housing Council. Prior to joining NMHC, Eileen served as Staff Director of the Environment Subcommittee of the Committee on Science, Space, and Technology of the U.S. House of Representatives. This Subcommittee had legislative and oversight authority for the research and development portfolios of the U.S. Environmental Protection Agency, the U.S. Department of Energy and the U.S. Department of Commerce. Eileen currently serves on the Board of Directors of the National Center for Housing and the Environment. She holds a Bachelor of Science and Masters of Science degrees from Villanova University and received a Ph.D. in microbiology from The Catholic University of America.*

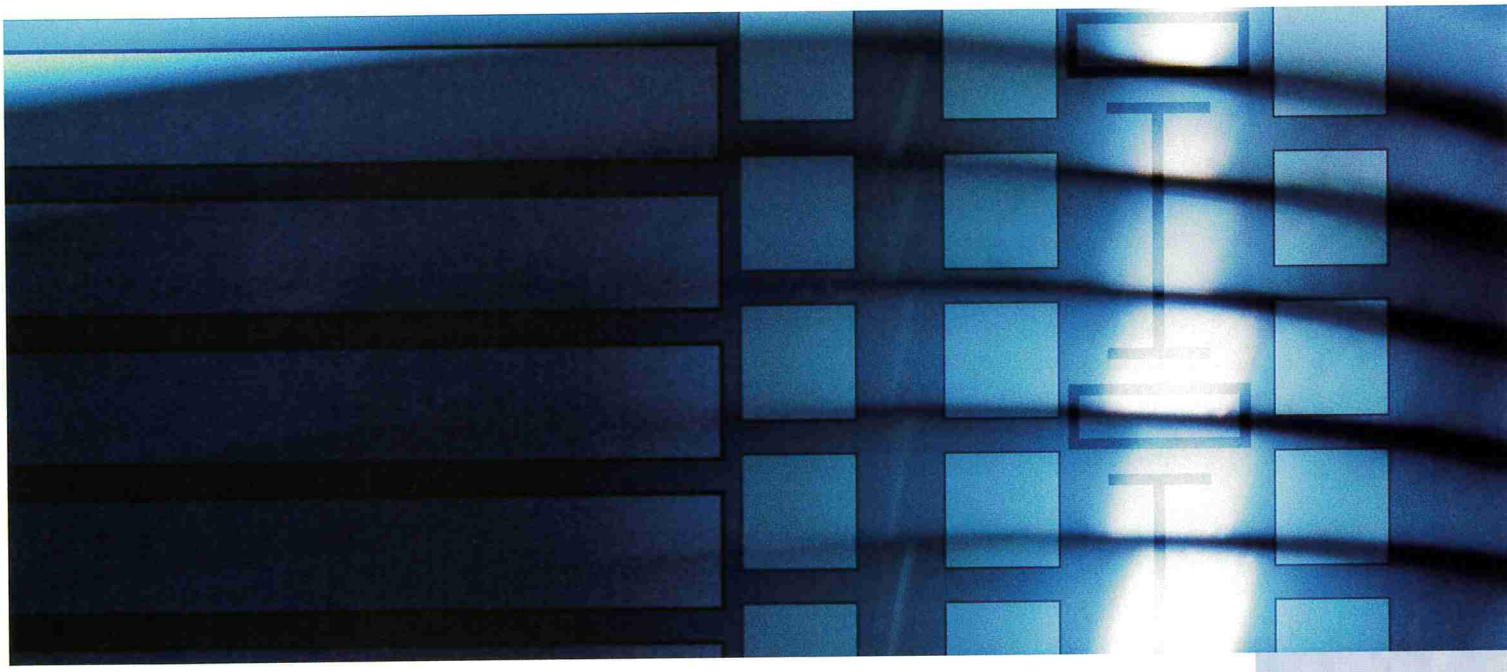
Copies of the report *Damp Indoor Spaces and Health (2004)*, prepared by the Board on Health Promotion and Disease Prevention of the Institute of Medicine, can be ordered at www.nap.edu/catalog/11011.html.
The EPA publication *A Brief Guide to Mold, Moisture, and Your Home* is publicly available at www.epa.gov/iaq/molds/moldresources.html.

ambient group inc.

Water Treatment Consulting

Heat Transfer Equipment
Piping Systems

www.ambientgroup.com



TOOLS OF THE TRADE

U.S. DEPARTMENT OF ENERGY

www.energy.gov

The U.S. Department of Energy (DOE) supports the development of commercial and residential buildings that are energy efficient, healthy and comfortable places to learn, work and play. The Office of Building Technologies within the DOE's office of Energy Efficiency and Renewable Energy offers a wide range of online resources for builders interested in high performance buildings.

High Performance Buildings Resources

www.eere.energy.gov/buildings/highperformance/

Visit the EERE's website for the following types of information on high performance buildings:

- **Design Approach:** Find answers to frequently asked questions about whole building design, costs, benefits and design guidelines.
- **Toolbox:** Special tools to assist design professionals are highlighted, including design guidelines, energy simulation software, resources, research reports, high performance building brochures, weather data and the charette handbook.
- **Technology:** High-performance buildings combine good design with energy advanced technologies to reduce energy consumption and environmental impact. Find information here on energy efficiency, passive solar design, solar water heating systems and solar electricity.

Building America

www.eere.energy.gov/buildings/building_america/

The U.S. Department of Energy offers a "Building America" program for residential builders, in which the knowledge and resources of industry leaders are combined with the DOE's technical capabilities. Building America is a private/public partnership that conducts research sponsored by the DOE to find energy-efficient solutions for new and existing housing that can be implemented on a production basis.

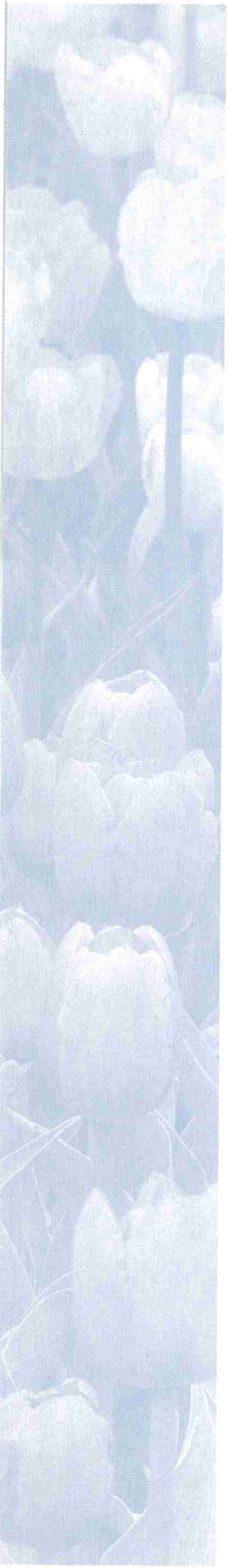
Building America conducts systems engineering research to:

- Produce homes on a community scale that use 40% to 70% less energy.
- Integrate onsite power systems leading to "zero-energy" homes that will ultimately produce as much energy as they use.
- Help home builders reduce construction time and waste.
- Improve builder productivity.
- Provide new product opportunities to manufacturers and suppliers.
- Implement innovative energy-and material-saving technologies.

High Performance Buildings Database

www.eere.energy.gov/buildings/highperformance/case_studies/

The High Performance Buildings Database, sponsored by the U.S. Department of Energy, seeks to improve building performance measuring methods by collecting data on various factors that affect a building's performance, such as energy, materials and land use. The database collects information from buildings around



the world, ranging from homes and commercial interiors to large buildings and even whole campuses and neighborhoods. These may be certified green projects, or simply projects that have one or more notable environmental features. Visitors to the site can search by project name, owner, location or building type and size. Detailed searches for advance users are also available. Information on more than 70 buildings is currently in the database.

Software Tools
www.eere.energy.gov/buildings/energy_tools/
The U.S. Department of Energy continues to develop a wide variety of building energy software tools. This site provides information about software tools now under development, as well as links to newsletters and email lists for users seeking additional help. Other helpful links include:

- **Tools Directory**
  www.eere.energy.gov/buildings/tools_directory/
  More than 280 energy-related software tools for buildings, with an emphasis on using renewable energy and achieving energy efficiency and sustainability in buildings. Tools are listed alphabetically, by platform or by country, and users can easily browse through the directory, which is divided into many sub-groups such as whole building analysis; material, components, equipment & systems tools; and codes and standards.

- **Energy Plus**
  www.eere.energy.gov/buildings/energyplus/
  Energy Plus is DOE's new generation building energy simulation program that builds on the most popular features and capabilities of BLAST and DOE-2. EnergyPlus includes innovative simulation capabilities, including time steps of less than an hour, modular systems simulation modules that are integrated with a heat balance-based zone simulation, and input and output data structures tailored to facilitate third party interface development. Other planned simulation capabilities include underfloor air distribution systems and electric power simulation, including fuel cells and other distributed energy systems.

WHOLE BUILDING DESIGN GUIDE

www.wbdg.org
The Whole Building Design Guide (WBDG) is a web-based portal providing government and industry practitioners with access to up-to-date information on a wide range of building-related guidance, criteria and technology from a "whole buildings" perspective. The WBDG is organized into two major categories, Design Guidance and Project Management.

Design Guidance is a resource for architects, engineers and project managers that provides guidance and recommendations under the following categories:

Building Types: For each general Building Type there is a discussion of the attributes and requirements of the type, as well as links to information on more specific uses. Each of the specific building types is then linked to a series of *Resource Pages* explaining standards, technologies and emerging issues relevant to that specific use topic.

Space Types: For each Space Types page there is a discussion of the general attributes and requirements of the space as well as example configurations and layouts. Space Types pages are also linked to related Building Types pages and Resource Pages that explain strategies, technologies and emerging issues relevant to that specific Space Type.

Design Objectives: The following design objectives are described in this section: accessible, aesthetic, cost effective, durable, functional, safe and sustainable.

Products & Systems: A concise listing of products and systems is offered and in the near future, the website will provide access to information on specific products and systems based on CSI MasterFormat™ Division or ASTM UNIFORMAT II Major Group Element.

Project Management offers guidance for the entire delivery team to successfully and effectively carry out a high performance building project. While this section is still under development, information on Project Delivery Teams, Project Planning and Development, and Project Delivery and Controls is offered. Most of the language in this section is for federal projects but may be applicable to other public sector institutions with adaptation for local standards of professional practice.

US GREEN BUILDING COUNCIL

www.usgbc.org
The US Green Building Council (USGBC) is the nation's foremost coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. The website homepage, www.usgbc.org, has links to the LEED website, green building resources, industry news, events and membership information.

The LEED website is extensive and includes links to information on training workshops, the LEED accreditation exam, LEED publications, a certified building project list, as well as the following:

- Building certification process: The information contained on this page outlines the required steps of the application process and answers the questions most frequently asked by project teams seeking LEED certification and project registration.

Members and those with registered projects can access Credit Interpretation Requests and rulings from 2001 through the present.

- Project registration: Project registration is the first step towards earning LEED certification for your building project and provides online access to the LEED Letter Templates (application submittals) and credit interpretations.

USGBC Resources brings you online green building tools and information from the USGBC and other organizations. USGBC members have access to additional Members-Only resources, including LEED credit rulings and comments, conference transcripts and presentations, the USGBC newsletter archives, member surveys, USGBC Strategic Plan and a fully searchable member directory. The USGBC newsroom provides links to information on green building issues and useful resources for the media.

The Council's event calendar includes USGBC, chapter and industry events of interest. The site has regular updates on training workshops and conferences. Information on USGBC Recurring Events includes Greenbuild (the annual USGBC International Conference) and Expo and LEED® Training Workshops.

BUILDING GREEN

www.BuildingGreen.com

BuildingGreen helps building industry professionals broaden their expertise with authoritative, independent information on environmentally responsible design and construction. Their online and print resources include:

- *BuildingGreen Suite*™, an online information service offering instant access to thousands of articles, in-depth features, product reviews, news and opinions are cross-referenced with more than 1,800 green building product listings and a database of over 90 high-performance building case studies.
- *Environmental Building News*™, an independent monthly newsletter featuring comprehensive, practical information on a wide range of topics related to sustainable building – from renewable energy and recycled-content materials to land-use planning and indoor air quality.
- *GreenSpec*® Directory, featuring information on more than 1,750 green building products carefully screened by the editors of Environmental Building News and organized according to the 16-division CSI MasterFormat™ system. Listings include product descriptions, environmental characteristics and considerations, and manufacturer contact information with Internet addresses.

BuildingGreen's resources are not sponsored by any industry or manufacturer fees. Their commitment is to provide their customers with comprehensive research, honest reporting, well-organized information, outstanding value and excellent service. To learn more, visit www.BuildingGreen.com or call 800-861-0954.

SUSTAINABLE BUILDINGS INDUSTRY COUNCIL

www.SBICouncil.org

The Sustainable Buildings Industry Council is an independent, nonprofit organization whose mission is to advance the design, affordability, energy performance and environmental soundness of U.S. buildings. The Council offers a large portfolio of practical, user-friendly, award-winning building design software packages, resource documents, training programs, videos and websites. SBIC teaches and advocates a 'whole building' approach to design that considers sustainability within the context of other major design objectives, including affordability, security, functionality and aesthetics. To learn more about the Council, its resources and workshops, and its membership, please visit www.SBICouncil.org.

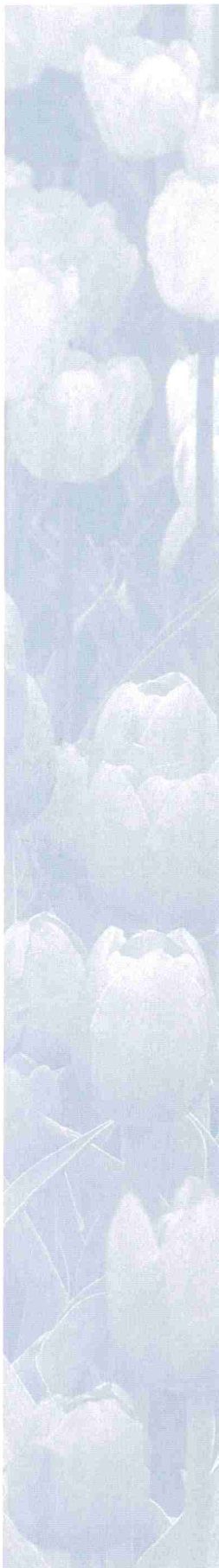
Designing Low-Energy buildings with Energy-10

SBIC's *ENERGY-10* software is a powerful design tool that analyzes - and illustrates - the energy and cost savings that can be achieved through more than a dozen sustainable design strategies. Hourly energy simulations help you quantify, assess and clearly depict the benefits of daylighting, passive solar heating, natural ventilation, well-insulated envelopes, better windows, lighting systems, mechanical equipment and more.

ENERGY-10 allows design professionals to weigh a variety of materials, systems and siting options to determine optimal results based on energy use, comparative costs and reduced emissions. The software is an invaluable aid for making informed decisions about energy performance during the crucial early phases of design, when sustainable building strategies and materials can be integrated at lowest cost. SBIC hosts two-day workshops that teach users how to utilize the software's features to their greatest advantage. *ENERGY-10*, version 1.5 and higher, has been approved for energy modeling to earn LEED credit points under EAc1 for appropriate projects. Low-rise residential and light commercial up to around 10,000 sf and certain larger facilities are good candidates for Energy-10 modeling.

Peer Reviews

For design professionals seeking in-depth expert design consultation beyond what traditional guidelines offer, SBIC offers Peer Reviews and Design Charrettes, as well as Customized Workshops. An expert team of SBIC member designers, engineers and energy analysts will



provide reviews of proposed building designs and recommend resource conservation and energy-efficiency strategies that are appropriate to your project and budget. By integrating daylighting, passive solar strategies, natural ventilation and renewable energy options, you can significantly reduce your operating costs over time, while creating a more healthful and productive environment. Costs vary based on location and level of review requested. For more information, email SBIC@SBICouncil.org.

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

www.nyserda.org

The New York State Energy Research and Development Authority (NYSERDA) is a public-benefit corporation established by the New York State Legislature in 1975. NYSERDA uses innovation and technology to solve some of New York's most difficult energy and environmental problems in ways that improve the State's economy. It does so by providing a variety of energy efficiency programs to commercial, industrial, business, institutional and residential customers. NYSERDA has many research and development programs and has produced consumer-oriented campaigns to educate the public about energy efficiency and its effect on the environment.

Energy Efficiency Services Program

NYSERDA's Energy Efficiency Services (EES) are helping thousands of businesses, industrial facilities, schools, residential customers and municipalities identify ways to reduce their energy costs. These programs are part of the **New York Energy $mart**[SM] program that receives funds from a System Benefits Charge (SBC), paid by electric distribution customers of investor-owned utilities. These utilities are: Central Hudson Gas and Electric Corporation, Niagara Mohawk Power Corporation, Consolidated Edison Company of New York, Inc., Orange and Rockland Utilities, Inc., New York State Electric and Gas Corporation and Rochester Gas and Electric Corporation.

Among the programs offered by NYSERDA under **New York Energy $mart**[SM] are the **New Construction and Green Buildings** programs, which offer developers, architects, engineers and other design team members cost-shared technical assistance and financial incentives to optimize the performance of new buildings, or buildings undergoing major renovations. The technical assistance, which is offered by NYSERDA on a 50/50 cost-shared basis, includes computer modeling, materials analysis, equipment and building commissioning. Technical assistance is also offered to assist in identifying cost-effective, energy-efficient products, equipment and systems that reduce environmental impacts and reduce life-cycle costs. Incentives under this program can cover up to 60% of the incremental costs of electricity-saving, energy efficiency measures.

Other programs include NYSERDA's **Energy Audit Program** designed to assist businesses and other facilities with annual electric bills of under $100,000. Energy audits are performed that aid these entities in making informed electrical energy decisions, implement energy efficiency strategies and identify improvements that will yield substantial energy savings.

NYSERDA's **New York Energy $mart**[SM] **Loan Fund Program** provides an interest rate reduction to qualified parties of up to 4.0% (400 basis points) for loan interest rates for a term up to 10 years. The loans are for certain energy efficiency improvements and/or renewable technologies and are available through participating lenders.

The **Commercial and Industrial Performance Program** offers financial incentives on a performance basis to contractors implementing cost-effective electrical efficiency improvements or demand reduction. Eligible measures include lighting, motors, variable-speed drives, energy-management systems, packaged air-conditioning and chillers and custom measures that result in electric demand reductions.

For a complete list of **New York Energy $mart**[SM] programs and a more detailed description of those listed above, visit the NYSERDA website at www.nyserda.org.

Research and Development Program

NYSERDA's Research and Development (R&D) program is divided into five areas: buildings; energy resources; environmental research; industry and applications; and transportation/power systems. The overall focus is on improving New York State's economic competitiveness and energy efficiency in an environmentally sound manner, while maximizing use of the State's renewable and indigenous resources. All NYSERDA R&D activity recognizes that energy, the economy and the environment are linked.

Buildings: Eligible projects that improve the energy efficiency of lighting, heating and cooling, electrical and envelope systems in commercial and residential buildings, as well as projects to improve energy efficiency in the low-income and multi-family housing sector, are sponsored through this program.

Energy Resources: Research is sponsored through this program that promotes the use of solar and wind energy, biomass as an energy source and chemical feedstock, and New York's natural gas and hydropower.

Environmental Research: NYSERDA develops and demonstrates energy-efficient technologies in the

areas of solid waste and sludge management, wastewater and drinking water treatment and environmental impacts through Environmental Research.

Industry and Applications: Through this program, NYSERDA works with New York industries to help them improve their industrial-process energy efficiency, minimize wastes, develop advanced materials and control systems, and promote the use of advanced energy systems.

Transportation/Power Systems: This program works both to reduce vehicle emissions and reduce New York State's dependency on petroleum products, as well as address research, development and demonstration needs associated with emerging distributed generation technologies.

Residential incentives and assistance is available through the **Residential Energy Affordability Program (REAP)**.

For more information about NYSERDA and its entire menu of programs, visit www.nyserda.org or call toll free 1-866-NYSERDA (1-866-697-3732).

EARTH DAY NEW YORK promotes environmental awareness and solutions through a three-pronged program:

Involving schools, teachers and students through the Earth Day Education Program
Educating public and private policymakers through conferences and publications
Involving the general public in annual Earth Day events

Lessons Learned: Four Times Square (1998)
Lessons Learned: High Performance Buildings (2001)
The Costs and Benefits of High Performance Buildings: Lessons Learned (2004)

Please contact us for information about Earth Day New York's publications and activities at 212-922-0048 or info@earthdayny.org or visit www.earthdayny.org.

EARTH DAY NEW YORK

201 East 42nd St., Suite 3200, New York, NY 10017
212-922-0048 (tel) 212-922-1936 (fax) info@earthdayny.org www.earthdayny.org

DAYLIGHTING, WINDOWS RESOURCE GUIDE

Recent Results from the Building Technologies Department Lawrence Berkeley National Laboratory
(For more information contact Maya Minamihara at MMinamihara@lbl.gov)

GENERAL WEBSITES

Lawrence Berkeley National Laboratory (LBNL) main site
http://www.lbl.gov/

LBNL Windows & Daylighting Group
http://windows.lbl.gov/

Efficient Windows Collaborative (residential windows)
http://www.efficientwindows.org

LBNL Lighting Systems Research Group: Controls and Communications
http://eetd.lbl.gov/btp/lsr/l_controls.html

STRATEGIC VIEWPOINTS ON DAYLIGHTING

The Elusive Challenge of Daylighted Buildings 25 Years Later
http://eetd.lbl.gov/btp/papers/41414.pdf

Advanced Fenestration Systems for Improved Daylight Performance
http://eetd.lbl.gov/btp/papers/41461.pdf

SMART DAYLIGHTING SYSTEMS

Automated Venetian Blinds

General Overview
http://eetd.lbl.gov/btp/papers/41443.pdf

Full-Scale Field Test: Energy and Control System Performance
http://eetd.lbl.gov/btp/papers/40509.pdf
http://eetd.lbl.gov/btp/papers/38130.pdf

Pilot Study on Occupant Satisfaction with Automated Blinds
See LBNL-40134 on http://eetd.lbl.gov/btp/pub/ISpub.html

Automated Roller Shades
The New York Times Building: Designing for Energy Efficiency Through Daylighting Research
http://www.lbl.gov/Science-Articles/Archive/sb-EETD-NYT-building.html

Smart Window Shades for Punched Window Applications
http://windows.lbl.gov/projects/dynamicshades/

Switchable Window Coatings

About Switchable Window Coatings on Glass
http://windows.lbl.gov/doeeci/how_they_work.htm
http://windows.lbl.gov/materials/chromogenics/default.htm
http://eetd.lbl.gov/btp/papers/37766.pdf

Switchable Reflective Hydrides
http://windows.lbl.gov/materials/chromogenics/hydrides.htm

Switchable Electrochromic Windows

New Daylighting Field Study
http://www.lbl.gov/Publications/Currents/Archive/Sep-19-2003.html#story4

Daylighting Field Test on Large-Area Electrochromic Windows
http://eetd.lbl.gov/btp/papers/45841.pdf
http://eetd.lbl.gov/btp/papers/45415.pdf

Visual Quality Assessment with Electrochromics
See LBNL-39471 at http://eetd.lbl.gov/btp/pub/BSpub.html

DOE-2 Energy Impacts of Electrochromic Windows
http://eetd.lbl.gov/btp/papers/34638.pdf
See LBNL-35486. Contact info at http://eetd.lbl.gov/btp/pub/WGpub.html.
See LBNL-35453 at http://eetd.lbl.gov/btp/pub/BSpub.html
See LBNL-39905 at http://eetd.lbl.gov/btp/pub/BSpub.html

Demand-Responsive Window and Lighting Control Systems

Demand-Response with Window Systems: Research and Industry Perspectives
http://eetd.lbl.gov/btp/papers/50855.pdf

Related Activities
http://www.lbl.gov/Science-Articles/Archive/EETD-demand-response.html

Internet-Based Control Systems for Building Energy-Efficiency

Overview
http://www.lbl.gov/Science-Articles/Archive/sb-EETD-internet-controls.html
http://eetd.lbl.gov/btp/papers/46009.pdf
http://eetd.lbl.gov/btp/papers/49975.pdf

Low-Cost Networking for Automated Window and Lighting Systems
http://eetd.lbl.gov/btp/buildings/hpcbs/
http://eetd.lbl.gov/btp/buildings/hpcbs/Element_3/02_E3_P2_2_3.html

DAYLIGHT-REDIRECTING WINDOW SYSTEMS

IEA Task 21 Daylighting in Buildings

IEA Website
http://www.iea-shc.org/task21/

Resource Book
http://gaia.lbl.gov/iea21/

IEA Task 31 Daylighting Buildings in the 21st Century
http://www.iea-shc.org/task31/

Determining Daylight Properties of Optically-Complex Window Systems
http://gaia.lbl.gov/hpbf/perfor_a.htm

Optically Complex Light Pipes and Light Shelves

Design and Performance
http://eetd.lbl.gov/btp/papers/38133.pdf
http://eetd.lbl.gov/btp/papers/34458.pdf

Palm Springs Chamber of Commerce Demonstration
See LBNL-38131 at http://eetd.lbl.gov/btp/pub/DApub.html

Angular Selective Glazings
http://eetd.lbl.gov/btp/papers/41694.pdf

Diffractive Holographic Glazings
http://eetd.lbl.gov/btp/papers/44167.pdf
See LBNL-35382 Rev at http://eetd.lbl.gov/btp/pub/DApub.html

DOUBLE-ENVELOPE AND OTHER ADVANCED FAÇADE SYSTEMS

High Performance Commercial Building Facades: (website and report)

This is a good overview piece on all types of advanced façade systems but focuses on all-glass buildings that are prevalent today.
http://gaia.lbl.gov/hpbf/
Report (pdf) can be downloaded at http://gaia.lbl.gov/hpbf/content.htm

DAYLIGHTING WITH INTEGRATED WINDOW AND LIGHTING SYSTEMS

General Overview

Progress Architecture Award 1999
http://windows.lbl.gov/comm_perf/daylight/default.html

Research Papers
http://eetd.lbl.gov/btp/pub/ISpub.html
http://eetd.lbl.gov/btp/papers/40967.pdf

Basic Principles: Optimizing Daylight versus Solar Heat Gains
See LBNL-32931 at http://eetd.lbl.gov/btp/pub/BSpub.html

HOW WINDOWS AFFECT PHOTOELECTRIC CONTROLS

Recent Work
LightFair Seminar 4/1/04 by Richard Mistrick, Doug Paton, and Francis Rubinstein

How Venetian Blinds Impact the Reliability of Daylighting Control Systems
http://eetd.lbl.gov/btp/papers/40867.pdf

Simulating Photosensor Controls with Radiance
http://eetd.lbl.gov/btp/papers/47544.pdf

DAYLIGHTING CONTROL SYSTEMS

Field Study at the San Francis Philip Burton Federal Building
http://eetd.lbl.gov/btp/papers/41633.pdf
http://eetd.lbl.gov/btp/papers/43096REV.pdf

Commissioning Daylighting Controls
http://eetd.lbl.gov/btp/papers/41010.pdf

DAYLIGHTING DESIGN AND DECISION-SUPPORT RESOURCES AND GUIDES

Commercial Windows Book
http://www.wwnorton.com/npb/nparch/carmody731219.html

Tips for Daylighting
http://windows.lbl.gov/pub/designguide/designguide.html

Daylight in Buildings: A Source Book on Daylighting Systems and Components:
http://gaia.lbl.gov/iea21/

Spectrally Selective Glazings
http://www.pnl.gov/fta/13_glazings/13_glazings.htm
Virtual Lighting Simulator: Explores impact of window design on daylighting
http://gaia.lbl.gov/vls/

SOFTWARE

LBNL Central Site
http://eetd.lbl.gov/Software.html

Radiance and Desktop Radiance: day/lighting design and rendering
http://radsite.lbl.gov/radiance/HOME.html

DElight: simulation engine for daylight and electric lighting system analysis in buildings.
http://eande.lbl.gov/Task21/DElightWWW.html

BDA: Building Design Advisor: Suite of Tools for Schematic Design
http://gaia.lbl.gov/BDA/

EnergyPlus, DOE-2: Hourly Building Energy Simulation programs
http://gundog.lbl.gov/

OPTICS: Analyzes optical properties of glazing systems
http://windows.lbl.gov/materials/optics5/default.htm

THERM: Analyzes 2-dimensional heat transfer through building products.
http://windows.lbl.gov/software/therm/therm.html

WINDOW: Analyzes window, thermal and optical performance.
http://windows.lbl.gov/software/window/window.html

FACILITIES

Window Systems and Façade Test Lab: Thermal and daylighting analysis of windows
http://www.lbl.gov/Publications/Currents/Archive/Sep-19-2003.html#story4

Glazing Optics Lab: Film and glazing characterization.
http://windows.lbl.gov/facilities/optics_lab/default.htm

Infrared Thermography Lab: Thermal analysis of windows.
http://windows.lbl.gov/facilities/irlab/default.htm

MOWiTT Facility: Window side-by-side thermal testing.
http://windows.lbl.gov/facilities/Mowitt/

New York Times Daylighting Mockup facility (Queens, N.Y.)
Website TBD, see windows.lbl.gov

Contacts:
Eleanor Lee, ESLee@lbl.gov
Stephen Selkowitz, SESelkowitz@lbl.gov

LEED-NC Version 2.1 Prerequisite and Credit Checklist

Yes	?	No			
SUSTAINABLE SITES					**14 Points**
Y			SSp 1	Erosion & Sedimentation Control	Prerequisite
			SSc 1	Site Selection	1
			SSc 2	Development Density	1
			SSc 3	Brownfield Redevelopment	1
			SSc 4.1	Alternative Transportation, Public Transportation Access	1
			SSc 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
			SSc 4.3	Alternative Transportation, Alternative Fuel Vehicles	1
			SSc 4.4	Alternative Transportation, Parking Capacity and Carpooling	1
			SSc 5.1	Reduced Site Disturbance, Protect or Restore Open Space	1
			SSc 5.2	Reduced Site Disturbance, Development Footprint	1
			SSc 6.1	Stormwater Management, Rate and Quantity	1
			SSc 6.2	Stormwater Management, Treatment	1
			SSc 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof	1
			SSc 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof	1
			SSc 8	Light Pollution Reduction	1

Yes	?	No			
WATER EFFICIENCY					**5 Points**
			WEc 1.1	Water Efficient Landscaping, Reduce by 50%	1
			WEc 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
			WEc 2	Innovative Wastewater Technologies	1
			WEc 3.1	Water Use Reduction, 20% Reduction	1
			WEc 3.2	Water Use Reduction, 30% Reduction	1

Yes	?	No			
ENERGY & ATMOSPHERE					**17 Points**
Y			EAp 1	Fundamental Building Systems Commissioning	Prerequisite
Y			EAp 2	Minimum Energy Performance	Prerequisite
Y			EAp 3	CFC Reduction in HVAC&R Equipment	Prerequisite
			EAc 1	Optimize Energy Performance	1 to 10
			EAc 2.1	Renewable Energy, 5%	1
			EAc 2.2	Renewable Energy, 10%	1
			EAc 2.3	Renewable Energy, 20%	1
			EAc 3	Additional Commissioning	1
			EAc 4	Ozone Depletion	1
			EAc 5	Measurement & Verification	1
			EAc 6	Green Power	1

Yes	?	No	MATERIALS & RESOURCES		13 Points
Y			MRp 1	Storage & Collection of Recyclables	Prerequisite
☐	☐	☐	MRc 1.1	Building Reuse, Maintain 75% of Existing Shell	1
☐	☐	☐	MRc 1.2	Building Reuse, Maintain 100% of Shell	1
☐	☐	☐	MRc 1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell	1
☐	☐	☐	MRc 2.1	Construction Waste Management, Divert 50%	1
☐	☐	☐	MRc 2.2	Construction Waste Management, Divert 75%	1
☐	☐	☐	MRc 3.1	Resource Reuse, Specify 5%	1
☐	☐	☐	MRc 3.2	Resource Reuse, Specify 10%	1
☐	☐	☐	MRc 4.1	Recycled Content, Specify 5% (post-consumer + _ post-industrial)	1
☐	☐	☐	MRc 4.2	Recycled Content, Specify 10% (post-consumer + _ post-industrial)	1
☐	☐	☐	MRc 5.1	Local/Regional Materials, 20% Manufactured Locally	1
☐	☐	☐	MRc 5.2	Local/Regional Materials, of 20% Above, 50% Harvested Locally	1
☐	☐	☐	MRc 6	Rapidly Renewable Materials	1
☐	☐	☐	MRc 7	Certified Wood	1

Yes	?	No	INDOOR ENVIRONMENTAL QUALITY		15 Points
Y			EQp 1	Minimum IAQ Performance	Prerequisite
Y			EQp 2	Environmental Tobacco Smoke (ETS) Control	Prerequisite
☐	☐	☐	EQc 1	Carbon Dioxide (CO2) Monitoring	1
☐	☐	☐	EQc 2	Ventilation Effectiveness	1
☐	☐	☐	EQc 3.1	Construction IAQ Management Plan, During Construction	1
☐	☐	☐	EQc 3.2	Construction IAQ Management Plan, Before Occupancy	1
☐	☐	☐	EQc 4.1	Low-Emitting Materials, Adhesives & Sealants	1
☐	☐	☐	EQc 4.2	Low-Emitting Materials, Paints	1
☐	☐	☐	EQc 4.3	Low-Emitting Materials, Carpet	1
☐	☐	☐	EQc 4.4	Low-Emitting Materials, Composite Wood & Agrifiber	1
☐	☐	☐	EQc 5	Indoor Chemical & Pollutant Source Control	1
☐	☐	☐	EQc 6.1	Controllability of Systems, Perimeter	1
☐	☐	☐	EQc 6.2	Controllability of Systems, Non-Perimeter	1
☐	☐	☐	EQc 7.1	Thermal Comfort, Comply with ASHRAE 55-1992	1
☐	☐	☐	EQc 7.2	Thermal Comfort, Permanent Monitoring System	1
☐	☐	☐	EQc 8.1	Daylight & Views, Daylight 75% of Spaces	1
☐	☐	☐	EQc 8.2	Daylight & Views, Views for 90% of Spaces	1

Yes	?	No	INNOVATION & DESIGN PROCESS		5 Points
☐	☐	☐	IDc 1.1	Innovation in Design: Provide Specific Title	1
☐	☐	☐	IDc 1.2	Innovation in Design: Provide Specific Title	1
☐	☐	☐	IDc 1.3	Innovation in Design: Provide Specific Title	1
☐	☐	☐	IDc 1.4	Innovation in Design: Provide Specific Title	1
☐	☐	☐	IDc 2	LEED™ Accredited Professional	1

Yes	?	No	PROJECT TOTALS (pre-certification estimates)	69 Points
☐	☐	☐	Certified 26-32 points Silver 33-38 points Gold 39-51 points Platinum 52-69 points	

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Mithūn Architects
Steven Winter Associates

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BUILDING AUTOMATION AND MANAGEMENT SYSTEMS
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Siemens Building Technologies

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JAM Consultants, Inc.

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ConEdison Solutions

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Bovis Lend Lease
Skanska USA Buildings, Inc.
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Hines
Jaros Baum & Bolles
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COOLING
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The Trane Company

CRITICAL POWER AND COOLING
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DATA AND TELECOM CENTERS
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WATERPROOFING
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American Institute of Architects New York Chapter is a professional society with 3,700 architect and affiliate members in Manhattan dedicated to design excellence, public advocacy and professional development. Founded in Lower Manhattan in 1857, the American Institute of Architects endeavors to speak to the intersection of design quality, environmental consciousness and public benefit in the built environment. For more information, please visit www.aiany.org.

Building Owners and Managers Association (BOMA/NY) was founded in 1967. BOMA/NY membership represents over 400 million square feet of commercial properties, three million office occupants and $1.5 billion in annual tax revenue. BOMA/NY's mission is to promote programs and services, while serving as a resource for the advancement of the commercial office building industry. For more information, please visit www.bomany.org.

LISC (Local Support Initiatives Corporation) is a national organization with 35 local offices dedicated to helping non-profit community development corporations (CDCs) revitalize distressed neighborhoods, both urban and rural. LISC mobilizes corporate, government and philanthropic support ($43 million in 2003) to provide CDCs with loans, grants and equity investments in housing, commercial, educational and other community projects ($650 million in 2003); technical and management assistance; and local, statewide and national policy support. Since its inception in 1980, LISC has marshaled more than $3.7 billion from 3100 investors, lenders and donors and leveraged it into development projects worth almost $13 billion: 147,000 affordable homes and 22 million square feet of retail, community and educational space. For more information, please visit www.lisc.org.

Mortgage Bankers Association (MBA) is the national association representing the real estate finance industry, an industry that employs more than 400,000 people in virtually every community in the country. The association works to ensure the continued strength of the nation's residential and commercial real estate markets; to expand homeownership prospects through increased affordability; and to extend access to affordable housing to all Americans. MBA promotes fair and ethical lending practices and fosters excellence and technical know-how among real estate finance professionals through a wide range of educational programs and technical publications. Its membership of approximately 2,700 companies includes all elements of real estate finance: mortgage companies, mortgage brokers, commercial banks, thrifts, life insurance companies and others in the mortgage lending field. For additional information, visit www.mortgagebankers.org.

National Association of Industrial and Office Properties (NAIOP) is the nation's leading trade association for developers, owners, investors and asset managers in industrial, office and related commercial real estate. Founded in 1967, NAIOP is comprised of more than 11,000 members in 49 North American chapters and provides networking opportunities, educational programs, research on trends and innovations and strong legislative representation. For more information, visit www.naiop.org.

National Association of REALTORS® (NAR), "The Voice for Real Estate," is America's largest trade association, representing one million members involved in all aspects of the residential and commercial real estate industries. For more information, please visit www.realtor.com.

National Multi Housing Council (NMHC) is a national association representing the interests of the larger and most prominent apartment firms in the U.S. NMHC advocates on behalf of rental housing, conducts apartment-related research, encourages the exchange of strategic business information, and promotes the desirability of apartment living. For more information, please visit www.nmhc.org.

New York Building Congress is a private association forging a common agenda among the diverse segments of the design, construction and real estate community. Celebrating its 83rd year, this coalition of contractors, subcontractors, developers, architects, engineers and skilled workers continues to advance issues and programs vital to the well-being of the entire industry and the City it serves. For more information, please visit www.buildingcongress.com.

Real Estate Board of New York (REBNY) consists of approximately 6,000 owners, builders, brokers, managers, banks, insurance companies, pension funds, real estate investment trusts, utilities, attorneys, architects and other individuals and institutions professionally involved in New York realty. The Board also speaks for the industry before government bodies and in the arena of public opinion and conducts various professional education programs, including state-certified required courses for licensing in some specialties. In addition, REBNY carries out a wide variety of real-estate-related information of any city trade association and serves as a vital force in civic and philanthropic affairs. For more information, please visit www.rebny.com

Real Estate Roundtable is the organization that brings together leaders of the nation's top public and privately-held real estate ownership, development, lending and management firms with the leaders of major national real estate trade associations to jointly address key national policy issues relating to real estate and the overall economy. For more information, visit www.rer.org.

Urban Land Institute (ULI) is a non-profit education and research institute that is supported by its members. Its mission is to provide responsible leadership in the use of land in order to enhance the total environment. ULI sponsors education programs and forums to encourage an open international exchange of ideas and sharing of experiences; initiates research that anticipates emerging land use trends and issues and proposes creative solutions based on that research; provides advisory services; and publishes a wide variety of materials to disseminate information on land use and development. Established in 1936, the Institute today has more than 20,000 members and full members from some 70 countries representing the entire spectrum of the land use and development disciplines. For more information, please visit www.uli.org.

US Green Building Council (USGBC) was established in 1993 and is the Nation's largest coalition of building industry organizations working to promote green building practices and principles.

US Green Building Council, New York was formed in 2002 to promote the design, construction and operation of buildings that are energy efficient, healthy, productive and environmentally responsible. The New York Chapter's mission is to promote green building in the greater New York City area. Please visit www.usgbc.org/chapters/newyork for additional information.

How to Make 'Green' Decisions That Make Dollars and Sense

Green architecture and interior design, as well as environmentally sensitive products, equipment, and systems for buildings, have come a long way in recent years. This means the potential for true economic and environmental benefits has increased significantly, but it also means that the number of options has increased to a point where **smart decision-making is crucial.**

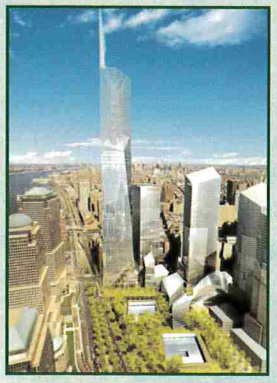
As an owner or tenant, you naturally want the most benefits from your green design and construction. At Tishman, we look at the whole picture. Because **our professionals have extensive knowledge and experience in the real-world application of green products, systems and equipment,** we can provide in-depth analysis of the multitude of choices available, and assist in determining which ones offer you the most attractive economic and environmental return on your investment.

As active members of the design and construction team, **we provide relevant input during the design phase when decisions are being made that will affect the entire life of the building and its operations indefinitely.**

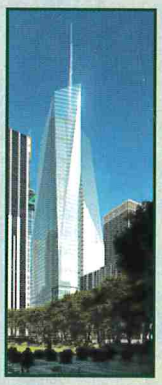
Tishman Construction and Tishman Research experts continually review and evaluate proposed products and systems from all angles: first cost/installation cost vs. operating cost and payback, constructibility, performance, and of course, fulfillment of your overall objectives.

We can also help in the field. Our personnel are thoroughly experienced in all on-site environmental requirements and environmentally sound procedures, including recycling of demolition materials and use of recycled materials by contractors.

Don't fall into the trap of not seeing the forest for the trees. **Put us on your green team by simply calling Dan Tishman (B.S., M.S., Environmental Sciences), President, Tishman Construction Corporation, at (212) 399-3680.**



Freedom Tower at World Trade Center



Bank of America Tower at One Bryant Park

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TISHMAN

Providing a full spectrum of 'green' pre-construction and construction services